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A STUDY OF DISTRIBUTION SYSTEM EQUALIZING STORAGE HYDRAULICS

by

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PREFACE

The studies reported herein comprise Part I of an investigation of "criteria for analysis of water distribution systems". The entire investigation has been supported by the Division of Water Supply and Pollution Control, U.S. Public Health Service, under Research Grant WP-526. Tentative titles for the other parts of the investigation are:

Part II - Applicability of Generalized Distribution Network Head Loss Characteristics.

Part III - Power Consumption for Equalizing Storage Operating Options.

Part IV - An Analysis of Distribution Demand Variability.

Part V - Ground-Storage Booster Pumping Hydraulics.

Principal investigator of U.S.PHS Research Grant WP-526: Professor M. B. McPherson.

ABSTRACT

Variables affecting the hydraulic characteristics of water distribution systems comprising a single pumping station, a pipe network and single elevated storage site are reduced to generalized parameters. Graphical presentation of results for typical demand variations are replaced by empirical equations. Results presented reveal limitations in contemporary concepts and design practice and serve as practical guides and criteria for more realistic designs.

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The first computer program used was written and verified by Mr. Gary Wood while he was a senior at the University of Illinois. This computer program was extensively modified and extended several times. Mr. Ramanand Prasad was responsible for all computer program modifications, the preparation of input and the scheduling of all computer runs, and preparation of Appendix V. Professor M. B. McPherson wrote the report and prepared all exhibits other than Appendix V.

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INTRODUCTION

The selection of components in the design of water distribution systems with a pumped sendout and equalizing storage has always been difficult because of the numerous variables involved, and in the absence of adequate criteria heavy reliance has been placed on expedient approximations. Once installed, elevated equalizing storage becomes a control on the hydraulic performance capability of a system. This control usually cannot be feasibly modified because of the permanent nature of an elevated tank and its supporting structure.

The objective of this study was to assess the effect of the several pertinent variables and to reduce the findings into useful guides and criteria for design. The scope of the study was necessarily restricted to consideration of systems with a single pumping station and a single elevated storage site; with one or more tanks at the same site. However, the results obtained should be useful in appraising the probable requirements for systems with multiple pumping stations and/or storage sites.

Detailed characteristics have been determined for a constant suction water level and given examples of variable suction water level schedules should serve as adequate guides for designer judgment modification in application to a particular system.

System component requirements have been determined only for full storage capacity recovery at the end of a 24-hour operating cycle. This is the most critical operating condition. Once a designer has decided on the demand schedule to be met with full storage recovery, components can be selected directly from information to be presented. With the system components thus fixed, operation under other demand schedules can be simulated by routine calculation.

While the study results should prove valuable in direct design application, as outlined directly above, their greatest value should be in investigating alternatives. A given demand schedule can be met with full storage capacity recovery employing several different combinations of components. The preferred combinations can be identified as those requiring least capital investment, and when the annual operating costs of the least-investment combinations are analysed the most economical case can be identified.

Using the results of this study in direct determination of required pump and/or tank capacities and heads requires only about three network balances, to determine characteristic network parameters. With pump and tank characteristics fixed in a design, required network characteristics must unfortunately be determined by trial-and-error modification of network piping, with about three network balances required for each modification.

Whether a McIlroy Fluid Network Analyzer or a digital computer is employed for the network balances is immaterial, the choice being resolved by other considerations.[1,2]

DESCRIPTION OF SYSTEM VARIABLES

(See next page for Definitions of Symbols)

For a single pump supplying the entire daily sendout to a network serviced by a single storage site, let the tank height Y between its full level and a reference suction water level, Figure 1(a), be considered as the dependent variable:

$$Y = f \text{ (Demand Schedule, Pump Characteristic Curve, Storage Capacity, Network Head-loss between Pump and Storage)} \quad (1).$$

The demand schedule can be characterised for present purposes by the demand for any particular hour, Q_d. The pump characteristic curve can be defined by the pump rated capacity Q_{pd}, rated total dynamic head E_{pd} and specific speed N_s. The storage capacity can be represented by the volume of available storage V within the usable range of storage levels T. Network head-loss between pump and storage, Σh, can be described in terms of the pumping rate at any hour Q_p, the hourly demand Q_d, and two constants Φ and n, under particularized conditions. Consequently, Eq. (1) can be rewritten as:

$$Y = f' \; (Q_d, Q_p, Q_{pd}, E_{pd}, N_s, V, T, \Phi, n) \quad (2).$$

A wide range of all variables was studied, with the ratio of largest to smallest values being on the order of two or more. In essence, the ranges covered should encompass the field of variability encountered in normal design practice with minor practical exceptions.

Incidental to the determination of the magnitude of the aforementioned variables for full storage recovery, other pertinent information was revealed, such as the minimum storage volume necessary for full recovery, U.

DEFINITIONS OF SYMBOLS

Q_d = hourly customer demand, mgd.

$\overline{Q_d}$ = mean of 24-hr. customer demand, mgd.

Q_p = hourly pumping rate, mgd.

Q_s = $Q_p - Q_d$ = flow rate to/from storage, mgd.

Q_{pd} = pump design capacity, mgd. ($Q_{pd} = \overline{Q_d}$ in this study).

Σh = $Q_d^{\,m}\, \Phi(Q_p/Q_d)^n$ = head-loss between pumping station and storage tank, feet; Φ, m, and n are constants.

m = exponent for network pipe head loss relation, i.e., $h = k_p Q^m$, where h is a branch head loss, Q the flow in the branch and k_p is the pipe coefficient accounting for length, diameter, friction coefficient and units.

a = amplitude of a sinusoidal demand schedule having the same demand volume for $Q_d > \overline{Q_d}$ as the actual demand schedule it is simulating, mgd.

a_s = amplitude of simulated sinusoidal variation in pump suction water level, feet, (see Fig. 5).

y = depth between full tank level and water level at a particular time, feet (see Fig. 1(a)).

$\overline{y}$ = depth between full tank level and mean water level for a given hour, feet (see Fig. 1(b)).

$\hat{y}$ = hypothetical mean depth of tank water level below tank overflow over 24-hr. cycle, for Q_p = constant = $\overline{Q_d}$, feet.

y_{max} = hypothetical maximum depth of tank water level below tank overflow over 24-hr. cycle, for Q_p = constant = $\overline{Q_d}$, feet.

y_s = departure of variable suction water level from mean, feet (see Fig. 5).

T = depth range of tank capacity, feet.

(Continued)

V = capacity of tank, mg.

U = volume of tank used in serving cycle of 24-hr. demand, mg.

Y = difference in elevation between full tank level and a reference pump suction water level, feet. (See Fig. 1(a) for constant suction water level and Fig. 5 for variable suction water level).

E_p = pump total dynamic head, feet.

E_{pd} = pump design total dynamic head, feet.

N_s = pump specific speed = $\left[N\sqrt{Q'_{pd}}\right]/E_{pd}^{3/4}$, where N is speed in rpm, Q'_{pd} is design capacity in gpm and E_{pd} is as above.

t = time.

Δt = time interval, one hour.

k_s = constant, for mean hourly sinusoidal demand, Eq. (8).

k_u = constant, empirical relation for U/a, Eq. (17).

Note: U.S. gallons throughout.

LIMITATIONS OF INVESTIGATION

Using the variability of actual demands, synthetic systems were studied having a single elevated storage site and a single pumping station sendout. Further, each 24-hour demand schedule was met by a single pump.

The head loss across the network between the pump and elevated storage was represented by

$$\Sigma h = Q_d^{\ m} \, \Phi(Q_p/Q_d)^n \tag{3}$$

where Σh is the head loss in feet, Q_d is the network customer demand in mgd, Q_p is the pumping rate in mgd, and Φ, m and n are constants. This relation was found suitable for proportional loading of practical networks[(3)]. For proportional loading all local demands are assumed to change in direct proportion with the total service-district demand.

The exponent m is the power to which the velocity or flow rate is raised in evaluating the head loss across individual pipe branches in a network, in $h = k_p Q^m$. While m = 1.85 is extensively used in water works practice, m can vary between 1.75 and 2 for the usual case with turbulent flow. Only three network balances are necessary in general to evaluate and verify Eq. 3, and Σh determined from network balances for given Q_d and Q_p with m = 1.85 for the branches can be used, with negligible loss of precision, to obtain Φ and n values compatible with those for m = 2:

$$\Sigma h/Q_d^{\ 2} = \Phi(Q_p/Q_d)^n \tag{4}$$

Restricting all computations to the integer m = 2 simplified interpretation and presentation of the results.

The elevated storage tank was assumed to have vertical walls, i.e., with the capacity per foot constant. Capacity per foot is then defined by the ratio of the usable storage volume, or capacity, V in mg to the range of usable storage T in ft. The range used was T = 25-ft, but the findings to be presented can be applied to any reasonable range by merely using the capacity per 25-ft for a deeper or shallower tank.

Requirements were determined only for full recovery of storage at the very end of a given 24-hr. demand cycle. Full recovery is an important design consideration and serves as a reference for anticipation of both premature and incomplete recovery conditions.

The pump characteristic curves used are generalized cases defined in terms of rated head and capacity. As a means of indexing the pump characteristics, the pump design capacity Q_{pd} was equated to the mean of the 24-hr. demand schedule $\overline{Q}_d$.

The majority of results are for a fixed suction water level, but from comparative special cases with a variable suction schedule it will be seen that the effect of suction water level variation may be negligible.

It must be noted in passing that Σh must represent not only network piping head losses, but for a given Q_p the pumping station head loss must be included, and likewise for a given Q_s the tank appurtenance head loss must be included.

SYSTEM BALANCES

System balances were performed on a wide variety of variables. A system balance is nothing more than a reconciliation of flows and heads for a given system over a selected time interval Δt, such as one hour, in sequential order of demands[2,3]. A sample system balance from the computer outputs is given in Table 1. For each hourly demand, trial values of pumping rate Q_p are assumed until the corresponding calculated total dynamic head satisfies adequately the pump characteristic curve. For both 0-1 hours and 11-12 hours the mean demand is $\overline{Q_d}$ = 10.61 mgd. Various trial Q_p for these two hours are shown in Figure 2, with the balanced points given in Table 1 which coincide with the pump curve indexed thereon.

Use of a mean hourly demand is an approximation, because demands are seldom steady for an hour. As a further approximation, pump total dynamic head E_p is computed assuming that the representative tank water level for the hour is the mean $\overline{y}$ between the level at the beginning of the hour y_t and at the end of the hour $y_t + 1$, Figure 1(b), in:

$$\text{Computed } E_p = Y + \Sigma h - \overline{y} \qquad (5).$$

The computed E_p is thus an approximation of the mean E_p over Δt.

The term $(Q_p - Q_d)/1.92$ in Table 1 is the change in tank water level over an hour in feet for a tank capacity of 0.08 mg/ft, or (Q_s mgd x 25-ft)/(24-hr. x 2 mg) = Q_s mgd/1.92, where $Q_s = Q_p - Q_d$ is the rate entering or leaving the tank. In Table 1 the final tank water level at the end of the 24-hr. cycle is 129.37-ft versus Y = 129.44-ft, i.e., virtually refilled. Several terms in the heading of Table 1 will subsequently become evident.

For the present study, with a given 24-hr. demand schedule, simulated network, storage volume and pump, the tank height Y required for full storage recovery at the end of the 24-hr. demand cycle was computed by iteration on Y. Each trial value of Y required a separate system balance. For example, the system balance in Table 1 is for the ninth iteration on Y. For the first iteration, Y was set equal to E_{pd} = 138.0 ft. For each iteration on Y, around five sub-iterations on Q_p were about par for each hour of demand Q_d. The total number of iterations required to arrive at the Table 1 results was therefore on the order of 30-50 (total counts were usually output only for the Y iterations). In a number of instances the total iterations for a run were in the hundreds, and in isolated cases exceeded a thousand.

DEMAND VARIABILITY

Some measure of the variability between actual demand schedules was needed as a basis for generalizing the findings. It was found that storage requirements for actual demand schedules could be satisfactorily approximated using an equivalent sine curve demand schedule. The volume represented by integrating the actual schedule Q_d for $Q_d > \overline{Q_d}$ (or, $Q_d < \overline{Q_d}$) over its time of occurrence was equated to a sine curve having the same volume above (or, below) its mean. For a period of 24-hr., inasmuch as the area above a sine curve mean, covering half its period, is twice its amplitude, a,

$$\sum_{i=0}^{12} (Q_d - \overline{Q_d})_i \, \Delta t = 2a \; (12\text{-hr.}/\pi) \qquad (6).$$

Dividing through by $\overline{Q_d}$ and equating the sinusoidal summation to the volume for any actual demand schedule,

$$a/\overline{Q_d} = \pi/24 \sum_{i=0}^{t} (Q_d/\overline{Q_d} - 1)_i \, \Delta t \qquad (7)$$

where the upper limit on t is determined by the number of hourly demands greater than $\overline{Q_d}$. The upper limit on t will usually be between 12 and 16 hours.

An example of an actual demand schedule and its sinusoidal equivalent is shown in Figure 3. The parameter $a/\overline{Q_d}$ is extremely useful in characterising actual demand schedules, as will be seen. Determination of $a/\overline{Q_d}$ for the demand schedule of Figure 3 is detailed in Table 2.

DEMAND AND PUMP CHARACTERISTICS USED

Seven actual demand schedules were chosen so as to obtain a well-distributed and wide range of $a/\overline{Q_d}$. These demand schedules, in terms of $Q_d/\overline{Q_d}$, are listed in Table 3 together with demand ratios for equivalent sine curves. Because in normal operation it would be expected that the tank would have been filled just prior to the incidence of above-average hourly demands, the demand cycles for all system balances were commenced with the first Q_d of the schedule greater than $\overline{Q_d}$, in the order given in Table 3.

Mean hourly sine curve demands can be determined by

$$Q_d/\overline{Q_d} = 1 + k_s(a/\overline{Q_d}) \ (24/2\pi) \tag{8}$$

Coefficients k_s are given in Table 4.

The magnitude of rates for the actual demand schedules used are presented in Table 5 (underlined), together with other available basic demand rates for each district.

Pump characteristics input to the computer appear in Table 6. These characteristics are ostensibly representative of specific speeds N_s of 2,200, 3,000 and 4,000[4,5,6]. For computer determination of the pump curve characteristic E_p for a system balance, as in Table 1, a polynomial interpolation sub-routine was used. To preclude indeterminacy in computation, the charecteristics of Table 6 were graphically extrapolated to $E_p/E_{pd} = 0$ and this limit for each N_s was also input to the computer.

Maximum E_{pd} for different suction lifts/heads recommended in the Standards of the Hydraulic Institute[7] for double-suction pumps are given in Table 7. Suction requirements for $N_s = 4,000$ are so rigorous that such a steep characteristic curve can seldom be used in water works design. Rather, lower N_s are more generally used for moderate to large sized pumping stations. The reason the steep $N_s = 4{,}000$ pump characteristic was used in this study was to insure full coverage of the possible range of application.

HYPOTHETICAL STORAGE HEIGHT

If a network without head loss Σh is assumed, and the pumping rate Q_p is held constant and equal to the mean demand $\overline{Q_d}$, $Q_p = Q_{pd} = \overline{Q_d}$ = constant and thereby $E_p = E_{pd}$ = constant, from which

$$Y = E_{pd} + \hat{y} \tag{9}$$

where $\hat{y}$ is the hypothetical mean depth below the full tank level over the 24-hr. cycle. For full recovery of storage at the end of the cycle, for an actual demand schedule,

$$\hat{y} = \frac{T\,\overline{Q_d}}{24\ (24)\ V} \sum_{i=0}^{24} \left[\sum_{i=0}^{24} (Q_d/\overline{Q_d} - 1)_i\ \Delta t \right] \tag{10}$$

Because Δt is taken over an hour, the constant is 24 hours and appears twice in the denominator, for the integration and the summation. With $\overline{Q_d}$ in mgd, V in mg and T in feet, $\hat{y}$ is in feet. A sample computation of $\hat{y}$ appears in Table 2.

For a sinusoidal demand, it will be found that

$$\hat{y} = (T/2\pi)\ (a/\overline{Q_d})\ (\overline{Q_d}/V),$$

or,

$$\hat{y} = (T/2\pi)\ (a/V) \tag{11}$$

Values of $\hat{y}$ for the actual and equivalent sinusoidal demand schedules used are listed in Table 8.

COMPUTED STORAGE HEIGHT REQUIRED

For a frictionless network ($\Phi = 0$), $E_{pd} - Y + \hat{y}$ should be small or approach zero for full storage recovery using any reasonable demand schedule and pump characteristic in a system balance. For this reason the parameter $E_{pd} - Y + \hat{y}$ was used as an argument in the figures of Appendix I. (All pertinent computer output values plotted in the figures of Appendix I are given in the tables of Appendix III).

From Eq. (4), Σh should be a function of $\Phi\overline{Q_d}^2$, the demand schedule and the pump characteristic, for a given n. At any given hour, $\Sigma h = E_p - Y + \overline{y}$ from Eq. (5). Consequently it was found that for a given demand schedule, N_s and n that $E_{pd} - Y + \hat{y}$ was a function of $\Phi\overline{Q_d}^2$, as anticipated.

In Table 9 are listed computed $E_{pd} - Y + \hat{y}$ for the sinusoidal demand schedules for $\Phi\overline{Q_d}^2 = 40$ and $n = 3$ and 4. This sample of the results is typical. It should be noted that the effect of pump characteristic curve steepness, defined by each N_s, is negligible except for the steepest characteristic ($N_s = 4{,}000$) and then only for the two largest $a/\overline{Q_d}$. As noted in referring to Table 7, an N_s of 4,000 is seldom used. Also, an n of 4 is the approximate upper extreme one would encounter in practice.

The initial water level for a 24-hr. cycle was always at Y. At this juncture it is necessary to state that iterations on Y were terminated when the water level at 24-hr. was lower than the initial by an amount less than 0.1-ft. The number of iterations on Y were generally limited to 99, and in special cases to 199 or more, and despite this occasionally the 0.1-ft criteria was not met. For those runs where the criteria was exceeded, in Appendices III and IV the difference between the final and full levels is given to the nearest tenth of a foot under "Y-FSTE". Any result marked by an asterisk, such as in Table 8, is for an "approximate run" where the 0.1-ft limit was exceeded. However, in plotting the results in Appendix I, only those runs for which the discrepancy was less than about half a foot were used.

Returning to Table 8, it should now be recognised that the computed $E_{pd} - Y + \hat{y}$ are not highly precise values and that no inferences can be drawn from subtle changes between one N_s and another. Because for all practical purposes there was no definite trend or significant difference between values for the three N_s, the seven figures in Appendix I are headed with all three N_s without discrimination. For the $a/\overline{Q_d} = 0.854$ results, points satisfying closely only $N_s = 2{,}200$ and $3{,}000$ were plotted, and Figure LA-1 is a rather crude approximation for $N_s = 4{,}000$ and $n = 4$, but this combination is of little practical importance.

Because results will be summarized in terms of the $a/\overline{Q_d}$ for equivalent sine curve demands, it is pertinent to note the closeness of curves for sinusoidal demands to the points plotted for the actual demands in Appendix I. An example of the consistency between sine and actual cases is presented in Table 10 for $a/\overline{Q_d} = 0.468$ and $\Phi\overline{Q_d}^2 = 40$. More important, it should be carefully noted that the results are either independent of the magnitude of both $\overline{Q_d}$ and E_{pd} or their effect is so small as to be obscured by the modest approximations permitted in the computations. Referring to Appendix III, it may be noted that widely differing $\overline{Q_d}$ and E_{pd} were used for all series of runs. With minor reservations, the results summarized in Appendix I are independent of the magnitude of $\overline{Q_d}$ and E_{pd} and should be generally representative of any reasonable combination of those two variables.

Recall the statement that $E_{pd} - Y + \hat{y}$ for $\Phi = 0$, or $\Phi\overline{Q_d}^2 = 0$, should be small or approach zero. Indeed, it was found that for all cases where $\Phi\overline{Q_d}^2 = 0$ the magnitude of $E_{pd} - Y + \hat{y}$ was a matter of a fraction of a foot or zero. Hence all the curves in Appendix I originate at the zero intercept, which is also the predominant plotting position for actual demand schedule points.

For n = 2, Eq. (4) degenerates in average terms into an independence of Σh from Q_d, or an independence from demand schedule. It is not surprising therefore that $E_{pd} - Y + \hat{y}$ for n = 2 is the same for all demand schedules, actual and sinusoidal:

$$E_{pd} - Y + \hat{y} = \Phi\overline{Q_d}^2; \; (n = 2) \qquad (12).$$

Eq. (12) is closely satisfied not only with all demand schedules but regardless of N_s, $\overline{Q_d}$ or E_{pd} employed. The practical lower limit for n is n = m = 2.

The generalized head loss parameter, Eq. (3), has been verified recently for m = 2 with Q_p/Q_d ranging between about 1/2 and 5 or more. In Table 11 are listed the largest and smallest hourly Q_p/Q_d of the computer system balances for each demand schedule and N_s. The range of Q_p/Q_d is independent of N_s for all but the largest $a/\overline{Q_d}$, offering some additional substantiation to the stated independence of $E_{pd} - Y + \hat{y}$ from pump characteristic curve steepness. (The values in Table 11 are for the runs plotted in the figures of Appendix I. Grossly approximate run data were ignored. The maximum and minimum for a given case is not necessarily from the same run, the same $\overline{Q_d}$ or same E_{pd}).

At the beginning of the study it was assumed that $Q_{pd}(= \overline{Q_d})$, E_{pd} and N would all affect the results for a given N_s, and for this reason commonly used electric drive synchronous speeds were used throughout, e.g., 1,750 rpm. Nevertheless, the results for $E_{pd} - Y + \hat{y}$, and $U/\overline{Q_d}$ to be described in the next section, were not only independent of N_s with minor exceptions, but also E_{pd} and $\overline{Q_d}$ and hence, also, N.

Although all demand schedule series were carried at least as high as $\Phi\overline{Q_d}^2 = 80$, it will be found that 50 is assuredly on the order of a practical upper limit.

Two separate days of typical demand schedules with a mean equal to the average annual were supplied by the Baltimore Bureau of Water for Towson Fourth Zone, with $a/\overline{Q_d}$ which both spanned and were very near to the 0.642 for Dallas North High. Using the clock-hour means for the two Towson Schedules, the $a/\overline{Q_d}$ became 0.642 with only a very minor adjustment. In Table 3 it may be noted that there is considerable difference between demand variations of Towson, North High and the sinusoidal equivalent. As a consequence of the very low Towson demand on the 20th hour, Table 3, satisfactory system balances could not be obtained in a reasonable number of iterations for $n = 4$. This is why Figure TO-1 is incomplete. For the runs with acceptable balances the largest required Q_p/Q_d was 12.3 on the 20th hour, Table 11. Despite the incompleteness of the Towson series, comparison of Figures TO-1 and NH-1 will reveal relatively minor differences between the Towson and North High results. For higher $\Phi\overline{Q_d}^2$, the Towson $E_{pd} - Y + \hat{y}$ are larger than those for North High by about one foot. Considering the large difference in time-distribution of hourly demands for those two schedules, both for the same $a/\overline{Q_d}$, a discrepancy of about one foot is not very significant.

COMPUTED STORAGE VOLUME REQUIRED

In estimating storage volume requirements the usual procedure is to determine the volume required for a constant system input. Graphically, this procedure is a special version of the Rippl diagram or mass-curve method. Under any guise it is misleading because the influence of Σh and the pump characteristic are ignored. As will be shown, this hypothetical case for $\Phi = 0$ has merit as an index or basing value.

Assuming a constant pumping rate, $Q_p = \overline{Q_d} = Q_{pd}$, and ignoring head loss with $\Phi = 0$, the maximum storage depth required for a given demand schedule is

$$y_{max} = (T/24)\ (\overline{Q_d}/V) \sum_{i=0}^{i=t} (Q_d/\overline{Q_d} - 1)_i\ \Delta t \tag{13}$$

where the upper limit on t is determined by the number of hourly demands greater than $\overline{Q_d}$, as in Eq. (7); and likewise the upper limit on t will usually be between 12 and 16 hours. A sample calculation of y_{max} is given in Table 2. Because the summation in Eq. (13) is identical with that in Eq. (7),

$$y_{max} = (T/\pi)\ (a/\overline{Q_d})\ (\overline{Q_d}/V),$$

or,

$$y_{max} = (T/\pi)\ (a/V) \tag{14}$$

and applies to both irregular and sinusoidal demand schedules under the above stated restrictions.

Combining Eq. (14) with Eq. (11), for a sinusoidal demand schedule $\hat{y} = y_{max}/2$. For an actual demand schedule $\hat{y}$ tends to approach $y_{max}/2$, as may be seen by comparing the $\hat{y}$ for a given $a/\overline{Q_d}$ and $V/\overline{Q_d}$ in Table 8.

Because the maximum storage volume in mg required is $U = y_{max}$ (V/T) for the hypothetical case under consideration, from Eq. (14),

$$\text{Hypothetical} \quad U/\overline{Q_d} = 1/\pi\ (a/\overline{Q_d}) = 0.318\ (a/\overline{Q_d}) \qquad (15).$$

The hypothetical $U/\overline{Q_d}$ from Eq. (15) is graphed as a heavy, horizontal dashed line in the figures of Appendix II. It may be noted that for n = 2 and for all n at $\Phi = 0$, both the actual and sinusoidal demand schedule results tend to approach the hypothetical $U/\overline{Q_d}$. The departure from the hypothetical increases somewhat as $V/\overline{Q_d}$ is diminished. In Table 12 are entered the $U/\overline{Q_d}$ for $\Phi = 0$ for all combinations computed. Only gross departures are significant because a number of the runs for the lesser $V/\overline{Q_d}$ for each demand schedule were approximate runs. The $U/\overline{Q_d}$ for all frictionless network cases in Table 12 are rather closely approximated by the hypothetical of 0.318 $a/\overline{Q_d}$. For the actual demand schedules the maximum difference is on the order of 7%; and more precise system balances would probably have resulted in even closer agreement. In essence, for $\Phi = 0$ the effect of a variable Q_p is negligible. A quick glance at any one of the computer result graphs in Appendix II will indicate that $\Phi = 0$ and n = 2 are special cases, however. (All pertinent computer output values plotted in Appendix II are given in the tables of Appendix III).

Use of $U/\overline{Q_d}$ as an argument in presentation of the results was a necessity for direct application in design. That $\Phi\overline{Q_d}^2/E_{pd}$ was the complementary argument, for n = constant, was ascertained through coaxial correlation via systematic scheduling of the various variables, and was completely unexpected. That $U/\overline{Q_d}$ is a function of $\Phi\overline{Q_d}^2/E_{pd}$ is demonstrated by the examples in Table 13. Note the wide range of other parameters for which this function holds. (Because evaluation of $E_{pd} - Y + \hat{y}$ was the principal objective, $\Phi\overline{Q_d}^2$ values were set at prescribed intervals and resulting values of $\Phi\overline{Q_d}^2/E_{pd}$, although close as in Table 13, were not often a perfect match. Holding N to standard synchronous speeds further constrained control of $\Phi\overline{Q_d}^2/E_{pd}$).

The remarks expressed about Table 13 are further substantiated in Table 14, for a different $a/\overline{Q_d}$. Here the rather modest and typical differences between the $U/\overline{Q_d}$ for the actual and sinusoidal demand schedules may be noted.

Although the practical upper limit for $\Phi\overline{Q_d}^2$ is probably about 50, for the magnitudes of variables used it was necessary in many cases to go as high as 100 to reach $\Phi\overline{Q_d}^2/E_{pd} = 0.5$, the maximum value which would probably be encountered in design.

EMPIRICAL STORAGE HEIGHT RELATIONS

While the use of equivalent sinusoidal demand schedules is of great value as a basis for characterising actual schedules, major interest would be in the results obtained for the actual schedules. The sinusoidal group are described by a single parameter, $a/\overline{Q_d}$, but this does not account for all the variability in actual schedules. Assuming that the actual schedules selected for the study are fairly typical, the results plotted in Appendix I figures were reduced to empirical equations to expedite application by obviating the need for interpolation between the given values of n, and then again between the given values of $a/\overline{Q}_d$. Because of the smoother distribution of sinusoidal demands, empirical equations based on them would provide more precise estimates than for the actual, but use of the equations would require a subjective estimate of the probable departure of actual schedule values from the sinusoidal.

The following relation was obtained from the results for the actual demand schedules, shown as plotted points in Appendix I:

$$E_{pd} - Y + \hat{y} = \Phi\overline{Q_d}^2 + [(n - 2)\ (2.7)\ (V/\overline{Q_d})^{-3/10}\ (\Phi\overline{Q_d}^2)^{1/2}\ (a/\overline{Q_d})^2] \quad (16).$$

Because the portion within the brackets becomes zero for n = 2, Eq. (16) reduces to Eq. (12) for n = 2 which, incidentally, was an excellent representation of actual demand results. For n = 2.5, the equation gives $E_{pd} - Y + \hat{y}$ that depart from the computer results by no more than about 1-ft, for n = 3 by no more than about 2-ft and for n = 4 by no more than about 3-ft. These limits are exceeded only in a very few instances, in general occurring for $\Phi\overline{Q_d}^2$ in excess of about 60. The $a/\overline{Q_d}$ = 0.854 results for N_s = 4,000 were disregarded because, as noted earlier, they are for the sole combination which did not exhibit a reasonable independence of $E_{pd} - Y + \hat{y}$ from N_s for n = 3 but particularly for n = 4.

More specifically, Eq. (16) values for $\Phi\overline{Q_d}^2 = 40$, which is near the probable upper limit for practical application, should give a fairly good indication of its suitability. For each n, forty-two combinations of $V/\overline{Q_d}$, N_s and demand schedule were planned for computation but for the actual demand schedules some were deemed unnecessary or were abandoned when computer running time became excessive. For n = 2.5, Eq. (16) values differed from the computer results by no more than 1-ft in all twenty-two combinations used with $\Phi\overline{Q_d}^2 = 40$. (If all forty-two combinations had been run the difference would not have been widened). For n = 3, in only three of the forty combinations used were the Eq. (16) values more than 1 1/2-ft from (lower than) the computer results, viz., for the Towson, Royal Oak and Los Angeles schedules, all at $N_s = 4{,}000$. For n = 4, in eleven of the thirty-four combinations Eq. (16) values were in excess of 2-ft from (lower than) the computer results, viz., for North High, Royal Oak and Los Angeles, mostly at $N_s = 4{,}000$. Had the Towson runs for n = 4 been successfully completed, the results for $N_s = 4{,}000$ would undoubtedly have exceeded the 2-ft limit. In general, there is a tendency for the actual demand schedule computer results to diverge, with the disparity commencing and enlarging at the highest amplitudes and being most pronounced at $N_s = 4{,}000$, much as in Table 9 for the sinusoidal demand schedules.

The use of Eq. (16), making due regard and allowance for the preceeding limitations, will be adequate to obtain directly $E_{pd} - Y + \hat{y}$, or indirectly $\Phi\overline{Q_d}^2$ and n, vastly expediting dependent design system balances. More important, a very good estimate of the effect of component design alternatives can be determined in a matter of a few minutes. The rather minor influence of $V/\overline{Q_d}$ should be noted, its exponent in Eq. (16) being only -3/10.

EMPIRICAL STORAGE VOLUME RELATIONS

The differences between the $U/\overline{Q_d}$ for the three N_s were not very great, but it was decided to graph the results independently, Appendix II. Accordingly, empirical equations were obtained for each N_s in the following form:

$$(U/\overline{Q_d})/(a/\overline{Q_d}) = U/a = (k_u \sqrt{(n-2)^2 \ (\Phi\overline{Q_d}^2/E_{pd})} + 0.564)^2 \qquad (17)$$

for which

N_s	k_u
2,200	-0.150
3,000	-0.125
4,000	-0.120

with $V/\overline{Q_d} = 0.20$.

A practical upper limit on $(n-2)^2 \ (\Phi\overline{Q_d}^2/E_{pd})$ would be about 1 for most systems. For values ≤ 1, the above relations gave an estimate of U which was within 10% of the computer run U for all actual demand schedules, except Tri-Service and Belmont. These lowest $a/\overline{Q_d}$ cases could have been better represented, but the form of Eq. (17) would have been much more elaborate, with two constants. In terms of practical usage such refinement seemed unnecessary. Equation (17) estimates of U, in general, were within 5% of computer results for the aforementioned limit of ≤ 1. Equation (17) threfore provides a reasonable substitute for the twenty-one plots in Appendix II of $U/\overline{Q_d}$ versus $\Phi\overline{Q_d}^2/E_{pd}$, and more important, obviates the otherwise necessary interpolation for differing values of n and $a/\overline{Q_d}$.

For $V/\overline{Q_d}$ other than 20% the differences in U are slight, as may be noted in Appendix II. With $V/\overline{Q_d}$ of 10% the above relations give values of U a trifle low and for $V/\overline{Q_d}$ of 40% the values of U are a trifle high.

The hypothetical U/a of $1/\pi = 0.318$ was approximated so closely for all actual demand cases for $\Phi = 0$ (see Table 12) and $n = 2$, that it was incorporated in the formulation of Eq. (17), i.e., $(0.564)^2 = 0.318$. Oddly, the actual demand schedule results for $\Phi = 0$ (and also $n = 2$) are closer to the hypothetical than those for the sinusoidal.

It should be noted in passing that $U/\overline{Q_d}$ exceeds $V/\overline{Q_d}$ in some cases in Appendix II, which appears inconsistent. However, recall that V as used is indexed to T = 25-ft. A U of 1.2 mg required with V = 1.0 mg merely means, for example, that a minimum T of 30-ft would be necessary for a 1.2 mg tank, with all of the 1.2 mg in that case being used. Also, although Figure I(a) shows a single tank, the volume V could be divided between two or more tanks at the storage site. Provided that tank appurtenance head losses were reasonably the same, the group would function as a single unit. It was not intended to imply, for example, that use of a single 5-mg elevated storage tank would be practicable.

APPLICABILITY OF EMPIRICAL STORAGE RELATIONS

Because the range of Q_p used is a vital operating cost consideration from the standpoint of pump efficiency, maximum and minimum hourly Q_p for the computer runs were studied. As might have been expected, for a given $V/\overline{Q_d}$ and E_{pd} the range of $Q_p/\overline{Q_d}$ (= Q_p/Q_{pd}) decreases for a larger N_s (steeper head curve); and for a given N_s the range of $Q_p/\overline{Q_d}$ increases slightly for smaller E_{pd} ($n > 2$). For a given E_{pd} and N_s the range of $Q_p/\overline{Q_d}$ decreases slightly as $V/\overline{Q_d}$ becomes larger. The results for $N_s = 2{,}200$ and 3,000 are practically the same, the effect of N_s being pronounced only for $N_s = 4{,}000$.

In Figure 4 are graphed maximum and minimum $Q_p/\overline{Q_d}$ versus $a/\overline{Q_d}$ for specified n and $\Phi\overline{Q_d}^2$. Only the results for actual demand schedules have been considered. The combination of N_s, E_{pd} and $V/\overline{Q_d}$ used has ranges of $Q_p/\overline{Q_d}$ that are typical of all the results, but to be on the safe side, are a trifle larger than would be the case for most applications. It should be noted that for both the maximum and minimum Q_p the lines for various n have their limit at $\Phi\overline{Q_d}^2 = 0$ (frictionless network), with the range of $Q_p/\overline{Q_d}$ increasing with $\Phi\overline{Q_d}^2$ and $a/\overline{Q_d}$ for a given n, except for $n = 2$.

The cutoff capacity of a centrifugal pump (determined largely by suction conditions, being a caviatation phenomenon) is commonly not much more than about 120% of design capacity. Using $Q_p/Q_{pd} = 1.2$ as an arbitrary upper limit, it is evident that demand schedules of high $a/\overline{Q_d}$, Figure 4, can be coupled only with networks having low n and/or $\Phi\overline{Q_d}^2$ values. For example, with $a/\overline{Q_d} = 0.85$, $n = 4$ and $\Phi\overline{Q_d}^2$ greater than about 10 the maximum Q_p/Q_{pd} exceeds 1.2 and the demand schedule would likely not be met realistically with a single pump for full equalization of storage at the end of the 24-hr. demand cycle. However, for $a/\overline{Q_d} = 0.85$, $n = 2.5$, $\Phi\overline{Q_d}^2 = 40$, the range of Q_p/Q_{pd} is between only about 1.15 and 0.86. If it were desired to hold Q_p/Q_{pd} between, say, 1.10 and 0.90, only demands with low $a/\overline{Q_d}$ could be considered.

Pumping power costs increase with the range of pumping rate because of reduced overall efficiency, and it comes as no surprise that more power would be required for otherwise equal demand schedules having greater variability. Figure 4 should be useful in estimating increased costs attributable to proposed service enlargements which would increase demand variability in terms of $a/\overline{Q_d}$.

In general, a demand with $a/\overline{Q_d}$ up to around 1/2 can be served efficiently with a single pump almost regardless of the network involved. Because the efficiency curve of a centrifugal pump is somewhat steeper for larger N_s, it appears that from the standpoint of efficiency lower N_s pumps would be preferred to meet highly variable demands. Despite intuitive expectations to the contrary, in the preceding presentation the effect of N_s on storage equalization has been shown to be minor, and in most cases, negligible.

In summary, with only occasional exception an N_s of 4,000 is beyond the range of normal water works usage because of demanding suction requirements, Table 7. Also, the maximum hourly Q_p for large $a/\overline{Q_d}$ is impracticably high for $n = 4$ and even for $n = 3$ with large $\Phi\overline{Q_d}^2$, Figure 4. The reader may recall that these conditions cover the range of Appendix I cases where $E_{pd} - Y + \hat{Y}$ was not independent of N_s, and are beyond reliable application of the empirical relation, Eq. (16). The above conditions are also beyond the range of $\Phi\overline{Q_d}^2/E_{pd}$ for which reliable estimates of $U/\overline{Q_d}$ can be obtained using Eq. (17). Therefore, the empirical equations turn out to be suitable for practically the full range of practical usage. Although the empirical equations have been developed from results for a constant suction water level, in the succeeding section it is shown that adjustment of the empirical equation results required to account for suction water level variations should be minor.

VARIABLE SUCTION WATER LEVEL

The datum for the tank height Y for a constant or fixed suction water level is defined in Figure 1(a). For a variable suction water level the datum for Y is taken at the mean suction water level, with variations about the mean defined by y_s, Figure 5. Suction variations have been simulated using a sinusoidal distribution with amplitude a_s. The incidence of maximum suction storage would generally coincide with maximum elevated storage availability. For this reason the maximum suction storage level of $y_s = -a_s$ was taken at the same time in the operating cycle as the commencement of demands greater than $\overline{Q_d}$, when the distribution system storage tank had been assumed initially full, and at the end of the 24-hour cycle when the tank was refilled.

Complete computations were made for variable suction combinations, employing sinusoidal demand schedules:

$a/\overline{Q_d}$	$V/\overline{Q_d} \times 100$	a_s, Feet	N_s
0.353	20%	2.5 & 5.0	2,200, 3,000 & 4,000
0.766	40%	2.5 & 5.0	2,200, 3,000 & 4,000

It should be noted that total suction water level ranges ($2a_s$) of 5-ft and 10-ft represent, respectively, moderate and large practical ranges.

Variable suction computer results are tabulated in Appendix IV.

Results for the limiting condition of a frictionless network ($\Phi = 0$ or $\Phi\overline{Q_d}^2 = 0$) are given in Table 15. Constant suction is represented by $a_s = 0$. The distribution equalizing storage volume parameter $U/\overline{Q_d}$ is changed by less than 2% as a_s is raised from zero to 5-ft., with the hypothetical value being more closely approached as a_s becomes larger. The effect of N_s is negligible.

In Table 16 are listed results for $a/\overline{Q_d} = 0.353$, $\Phi\overline{Q_d}^2 = 40$, with $\overline{Q_d} = 20$ mgd. There is no effect of a_s on the magnitude of $E_{pd} - Y + \hat{y}$. The effect of a_s on $U/\overline{Q_d}$ is negligible, as is the effect of N_s. This insensitivity of $U/\overline{Q_d}$ and $E_{pd} - Y + \hat{y}$ to a_s and N_s was also evidenced for higher and lower $\Phi\overline{Q_d}^2$, for the $\overline{Q_d}$ and E_{pd} of Table 16 as well as for $\overline{Q_d} = 10$ mgd with lower E_{pd}.

Table 17 is also for $\Phi\overline{Q_d}^2 = 40$ with $\overline{Q_d} = 20$ mgd, but with $a/\overline{Q_d} = 0.766$, the next to largest amplitude studied for a constant suction water level. Again, there is no effect of a_s on the magnitude of $E_{pd} - Y + \hat{y}$ and the effect on $U/\overline{Q_d}$ is negligible. Values of $E_{pd} - Y + \hat{y}$ for $N_s = 2{,}200$ and $3{,}000$ are practically identical, but are consistently higher for $N_s = 4{,}000$, mostly with $n = 4$ where the difference is almost 4-ft. This disparity has been cited earlier in the discussion of constant suction results for the two highest $a/\overline{Q_d}$.

Table 18 is also for $a/\overline{Q_d} = 0.766$ with $\overline{Q_d} = 20$ mgd, but with $\Phi\overline{Q_d}^2 = 20$; and the comments made with respect to Table 17 are again applicable except that the $E_{pd} - Y + \hat{y}$ values for $N_s = 4{,}000$ and $n = 4$ are higher by about 2.3-ft as opposed to almost 4-ft for $\Phi\overline{Q_d}^2 = 40$. Table 19 is for the same conditions as Table 18 except that $\overline{Q_d} = 10$ mgd, E_{pd} are also lower, and $n = 2$ has been omitted. The values in Table 19 of $E_{pd} - Y + \hat{y}$ for $N_s = 4{,}000$ and $n = 4$ are higher than for the other two N_s by about 2-ft, similar to the disparity in Table 18. However, for all three N_s with $n = 4$ the effect of reducing E_{pd} is an attenuation in $E_{pd} - Y + \hat{y}$ of about 3-ft. (The effect of reducing E_{pd} for high $a/\overline{Q_d}$ is much greater than the effect of reducing $\overline{Q_d}$).

If consideration is restricted to $n \leq 3$ for $a/\overline{Q_d}$ exceeding about 2/3, the corresponding results graphed in Appendices I and II are independent of the effect of N_s or the magnitude of E_{pd}. Referring to Figure 4, it is extremely doubtful that a single pump would be used for large $a/\overline{Q_d}$ with $n = 4$. Also, it has been found that an n of 4 is an extreme case, for a storage tank linked to the network via a long connecting main. For $a/\overline{Q_d}$ less than about 2/3 there are no restrictions on the results graphed in Appendices I and II.

With the immediately preceding modest reservations, it may be fairly stated that the effect of the selected suction water level schedules was negligible for a sinusoidal system demand schedule. Using either the selected suction water level schedule or an actual case in combination with actual system demand schedules, the divergence of results from those presented in Appendices I and II should be nominal and performance should be satisfactorily predicted by Equations (16) and (17).

CONCLUSIONS

Variables affecting the hydraulic characteristics of water distribution systems comprising a single pumping station, a pipe network and a single elevated storage site have been reduced to generalized parameters. Graphical presentation of results for some typical actual demand variations have been replaced by empirical relations.

While the scope of the study was necessarily limited to systems with a single pumping station and a single elevated storage site, results obtained should be useful in appraising probable requirements for systems with multiple pumping stations and/or storage sites.

System component requirements have been determined only for full storage capacity recovery at the end of a 24-hr. operating cycle, because this is the most critical operating condition. Once the decision is made as to what demand schedule should be met with full storage recovery, necessary system components can be selected using Equations (16) and (17). However, although Equations (16) and (17) are good representations for the demand schedules that have been used, other schedules might not be so closely satisfied and a system balance for the full storage recovery condition should always be made as a check. Once all characteristics of system components have been designated, operation under other demand schedules can be simulated by means of a system balance for each demand schedule of concern. The Part III report of this investigation will apply the results in the study reported here to different operating design options, using a full year of actual hourly demands.

While the results presented should prove valuable in direct design application, their greatest value should be found in the investigation of alternatives, to identify the most economical combination of unconstrained possibilities.

The ratio $U/\overline{Q_d}$ was indexed in these studies to a volume V with a range of usable storage level T of 25-ft., but the results presented can be applied to any reasonable range to be made available by merely using the capacity per 25-ft. for a deeper or shallower tank.

Computations were restricted to $m = 2$ in the head loss relation. For proper use of the reported results, $\Sigma h/\overline{Q_d}^2$ versus (Q_p/Q_d) should be plotted on log-log paper using network balance results for $m \neq 2$, and the equivalent Φ and n for $m = 2$ should be determined therefrom.

With the exception of $n > 3$ with $a/\overline{Q_d} > 2/3$, approximately, the effect of pump characteristic curve steepness on $E_{pd} - Y + \hat{Y}$ was imperceptible; also, the magnitude of $\overline{Q_d}$ or E_{pd} had no effect on the results. Because cases representing coincident occurrence of $n > 3$ and $a/\overline{Q_d} > 2/3$ with large $\Phi\overline{Q_d}^2$ could not be served by a single pump, due to the intolerable range of $Q_p/\overline{Q_d}$ required, it may be safely concluded that the remaining portions of the results presented are of immediate value, being independent of pump characteristic curve steepness and the magnitude of E_{pd} or $\overline{Q_d}$.

The volume of storage used expressed as $U/\overline{Q_d}$ was found to be a function of $\Phi\overline{Q_d}^2/E_{pd}$, and was for all practical purposes independent of the magnitude of Q_d and E_{pd} for a given N_s. Modest differences in $U/\overline{Q_d}$ were evident between the three N_s results, indicating a slight dependence on pump characteristic curve steepness.

Required storage volume for a frictionless system using actual demand schedules was found to be closely approximated by the hypothetical case commonly used in design, wherein the volume is computed holding the pumping rate constant. However, from results presented it is evident that the hypothetical case would be a gross overestimation for systems containing networks with significant head loss.

Empirical relations have been presented, Equations (16) and (17), based on the results for the actual demand schedules used in the study. These equations largely substitute for and extend the usefulness of the graphs in Appendices I and II. Using these equations, a very good estimate of the effect of component design alternatives can be assessed in a matter of a few minutes. Equation (17) was developed from data for $V/\overline{Q_d} \times 100 = 20\%$; however, this relation is a good approximation for 10% to 20% or 20% to 40%, depending on the magnitude of $a/\overline{Q_d}$. One of the most unexpected findings of the study was the relative insensitivity of the results to the capacity per foot of equalizing storage.

Using specific variable suction water level schedules in conjunction with sinusoidal demand schedules, it has been found that the effect of a variable suction can be negligible. It is therefore expected that performance for actual demand schedules coupled with actual suction variations will generally be anticipated satisfactorily by means of Equations (16) and (17), developed from constant suction computer run results.

Nearly 2,000 computer runs were made in this study. The result for each run was the determination of a tank height Y for which storage was replentished exactly at the end of a 24-hr. operating cycle. The total number of iterations on Y required to arrive at these equalization results was upwards of one-hundred thousand. It would take at least one man-year merely to check the approximately 2,000 computer run final results using a desk calculator. The dependence of this study on the availability of a high-speed digital computer is quite obvious. The IBM 7094 of the University of Illinois was used for all computer runs.

There may be justified criticism of the use of the generalized distribution head loss relation, Eq. (3), which is restricted to proportional loading. One part of the investigation, Part II, has been concerned with the determination of the validity and limitations of this relation. It has been found that the addition of more terms would result in a relation which would yield more precise results. However, had a more elaborate relation been used the scope of the present study would necessarily have been curtailed because much more computer running time would have been required. Extending the study to non-proportional loading conditions was not considered realistic because a multitude of load combinations could be conceived. Rather, network balance results for non-proportional loading can be approximated using their best fit to Eq. (4) for application of the findings in this report.

CLOSING REMARKS

At the time of writing, a condensation of the present report is scheduled to be presented as a paper before the ASCE Annual Meeting and Environmental Engineering Conference at Kansas City, Missouri on October 19, 1965. If available session time permits it is planned also to summarise the more important findings from Part II, Applicability of Generalized Distribution Network Head Loss Characteristics. Mr. Richard A. Wiseman, research assistant, has done nearly all the work on Part II.

Summaries of Part III on Pumped Equalizing Storage Operation Options and Part IV on An Analysis of Distribution Demand Variability are scheduled for presentation before the Research session of the Annual Conference of AWWA at Portland, Oregon, July 1, 1965. The work on Part III will be reported by Professor M. B. McPherson and Mr. R. Prasad. The work on Part IV will be presented by Dr. Gordon Gracie, who will have done all of the variability analyses.

Time permitting, it is planned to extend the findings from Part IV to projections of demands using techniques of synthetic hydrology. In Part V a preliminary investigation will be made of ground-storage with booster pumping, the major alternative to elevated equalizing storage. Findings on Ground-Storage Booster Pumping Hydraulics will be presented by M. B. McPherson before a joint meeting of the W.P.C.F. and A.W.W.A. Rocky Mountain Sections at Albuquerqae, New Mexico in October, 1965.

A paper entitled "Pumped Equalizing Storage Operating Options" by M. B. McPherson and Gary Wood was offered for publication to the Journal, AWWA in May, 1964. This paper was based on hand calculations made before the computer program had been written and was intended as a published introduction to Part III results.

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TABLE 1

Sample System Balance

Given:

For Sinusoidal demand Schedule with $a/\overline{Q}_d = 0.468$
$\overline{Q}_d$ = 10 mgd = Q_{pd}; V = 2.0 mg
E_{pd} = 138.0 feet; N_s = 3,000; N = 1,450 rpm
Y = 129.44 feet (suction W.L. constant)
$\Phi\overline{Q}_d^{\,2}$ = 15.0 (feet)
$\Phi\overline{Q}_d^{\,2}/E_{pd}$ = 0.109
$\hat{y}$ = 9.3 feet
$E_{pd} - Y + \hat{y}$ = 17.9 feet

Results:

Tank W.L. @ 24-hours = 129.37 feet (vs. Y = 129.44 feet)
$U/\overline{Q}_d$ = 0.1287 mg/mgd (64.4% of 2.0 mg used)
U/a = 0.2751 mg/mgd

Time, hours	Q_d, mgd	Q_p (by trial) mgd	$\frac{Q_p - Q_d}{1.92}$, feet	Mean Tank Water Level Over Interval, feet	Σh (m=2, n=3, Φ=0.15), feet	E_p, Total Dynamic Head (Computed), feet	E_p, Total Dynamic Head (Characteristic), feet	Tank Water Level @ End of Interval, feet
0-1	10.61	9.57	-0.54	129.17	12.40	141.57	141.59	128.90
1-2	11.79	9.75	-1.06	128.37	11.78	140.15	140.19	127.84
2-3	12.84	9.94	-1.51	127.09	11.46	138.55	138.59	126.33
3-4	13.71	10.14	-1.86	125.40	11.39	136.79	136.84	124.47
4-5	14.32	10.33	-2.08	123.43	11.55	134.98	135.03	122.39
5-6	14.63	10.51	-2.14	121.32	11.91	133.23	133.29	120.25
6-7	14.63	10.67	-2.07	119.22	12.45	131.67	131.72	118.18
7-8	14.32	10.79	-1.84	117.26	13.15	130.41	130.50	116.34
8-9	13.71	10.86	-1.48	115.60	14.03	129.63	129.71	114.86
9-10	12.84	10.89	-1.02	114.35	15.07	129.42	129.46	113.84
10-11	11.79	10.85	-0.49	113.60	16.25	129.85	129.86	113.35
11-12	10.61	10.74	+0.07	113.38	17.54	130.92	130.95	113.42
12-13	9.39	10.58	+0.62	113.73	18.89	132.62	132.67	114.04
13-14	8.21	10.35	+1.11	114.60	20.25	134.85	134.87	115.15
14-15	7.16	10.08	+1.52	115.91	21.43	137.34	137.38	116.67
15-16	6.29	9.78	+1.82	117.58	22.29	139.87	139.95	118.49
16-17	5.68	9.50	+1.99	119.49	22.65	142.14	142.16	120.48
17-18	5.37	9.28	+2.04	121.50	22.32	143.82	143.86	122.52
18-19	5.37	9.14	+1.96	123.50	21.34	144.84	144.88	124.48
19-20	5.68	9.09	+1.78	125.37	19.85	145.22	145.25	126.26
20-21	6.29	9.11	+1.47	126.99	18.06	145.05	145.08	127.73
21-22	7.16	9.18	+1.05	128.25	16.23	144.48	144.57	128.78
22-23	8.21	9.29	+0.57	129.06	14.66	143.72	143.77	129.35
23-24	9.39	9.43	+0.02	129.36	13.37	142.73	142.75	129.37

Versus
Y=129.44

TABLE 2

Example, Computation of $a/\overline{Q}_d$, $\hat{y}$ and y_{max}

(Champaign-Urbana Peak Day)

Time, Δt, Hours	$Q_d/\overline{Q}_d$	$Q_d/\overline{Q}_d - 1$	$\sum_{i=1}^{t} (Q_d/\overline{Q}_d - 1)_i \, \Delta t$
0-1	1.093	0.093	0.093
1-2	1.072	0.072	0.165
2-3	1.139	0.139	0.304
3-4	1.121	0.121	0.425
4-5	1.222	0.222	0.647
5-6	1.200	0.200	0.847
6-7	1.214	0.214	1.061
7-8	1.310	0.310	1.371
8-9	1.173	0.173	1.544
9-10	1.347	0.347	1.891
10-11	1.451	0.451	2.342
11-12	1.437	0.437	2.779
12-13	1.300	0.300	3.079
13-14	1.409	0.409	3.488
14-15	1.091	0.091	3.579
15-16	0.956	-0.044	3.535
16-17	0.573	-0.427	3.108
17-18	0.427	-0.573	2.535
18-19	0.365	-0.635	1.900
19-20	0.412	-0.588	1.312
20-21	0.411	-0.589	0.723
21-22	0.478	-0.522	0.201
22-23	0.816	-0.184	0.017
23-24	0.983	-0.017	0

$$\sum_{i=1}^{24} \left[\sum_{i=1}^{24} (Q_d/\overline{Q}_d - 1)_i \, \Delta t \right] = \underline{36.946}$$

$$\frac{a}{\overline{Q}_d} = 3.579 \, \frac{\pi}{24} = \underline{0.468}, \text{ Eq. (7).}$$

For $V/\overline{Q}_d = 0.20$,

$$\hat{y} = \frac{36.95 \ (25\text{-ft})}{24 \ (0.20) \ 24} = \underline{8.0\text{-ft}}., \text{ Eq. (10).}$$

$$y_{max} = \frac{3.58 \ (25\text{-ft})}{24 \ (0.20)} = \underline{18.7\text{-ft}}., \text{ Eq. (13).}$$

TABLE 3

Distribution of Demands, Multiple of Mean, $Q_d/\bar{Q}_d$

Time, Δt, Hours	$a/\bar{Q}_d$ = 0.232 (Tri-Service Peak Day) SINE	ACTUAL	$a/\bar{Q}_d$ = 0.353 (Belmont H.S. Typical Day) SINE	ACTUAL	$a/\bar{Q}_d$ = 0.468 (Champaign-Urbana Peak Day) SINE	ACTUAL	$a/\bar{Q}_d$ = 0.642 SINE	(North High Peak Day) ACTUAL	(Towson Typical Day) ACTUAL	$a/\bar{Q}_d$ = 0.766 (Royal Oak Peak Day) SINE	ACTUAL	$a/\bar{Q}_d$ = 0.854 (L.A. Co. Peak Day) SINE	ACTUAL
0-1	1.030	1.068	1.046	1.032	1.061	1.093	1.084	1.206	1.305	1.100	1.091	1.111	1.292
1-2	1.089	1.302	1.135	1.247	1.179	1.072	1.245	1.202	1.472	1.292	1.182	1.326	1.662
2-3	1.141	1.313	1.214	1.258	1.284	1.139	1.390	0.953	1.644	1.465	1.227	1.518	1.662
3-4	1.183	1.322	1.279	1.312	1.371	1.121	1.508	1.049	1.541	1.606	1.273	1.676	1.600
4-5	1.214	1.263	1.325	1.258	1.432	1.222	1.592	1.044	1.429	1.706	1.318	1.787	1.631
5-6	1.229	1.107	1.349	1.194	1.463	1.200	1.635	1.297	1.338	1.757	1.364	1.844	1.477
6-7	1.229	1.102	1.349	1.194	1.463	1.214	1.635	1.193	1.315	1.757	1.500	1.844	1.631
7-8	1.214	1.043	1.325	1.140	1.432	1.310	1.592	1.253	1.105	1.706	1.454	1.787	1.692
8-9	1.183	1.045	1.279	1.097	1.371	1.173	1.508	1.763	1.234	1.606	1.273	1.676	1.754
9-10	1.141	1.038	1.214	1.108	1.284	1.347	1.390	2.062	1.396	1.465	1.454	1.518	1.785
10-11	1.089	1.098	1.135	1.129	1.179	1.451	1.245	1.961	1.431	1.292	1.636	1.326	1.323
11-12	1.030	1.066	1.046	1.215	1.061	1.437	1.084	1.764	1.366	1.100	1.818	1.111	1.015
12-13	0.970	1.004	0.954	1.323	0.939	1.300	0.916	1.161	1.332	0.900	1.991	0.889	0.800
13-14	0.911	0.857	0.865	1.161	0.821	1.409	0.755	0.649	0.872	0.708	1.273	0.674	0.615
14-15	0.859	1.002	0.786	1.032	0.716	1.091	0.610	0.330	0.768	0.535	0.727	0.482	0.492
15-16	0.817	1.143	0.721	0.968	0.629	0.956	0.492	0.330	0.820	0.394	0.500	0.324	0.369
16-17	0.786	0.798	0.675	0.903	0.568	0.573	0.408	0.301	0.583	0.294	0.273	0.213	0.215
17-18	0.771	0.754	0.651	0.796	0.537	0.427	0.365	0.351	0.329	0.243	0.282	0.156	0.215
18-19	0.771	0.741	0.651	0.656	0.537	0.365	0.365	0.329	0.351	0.243	0.318	0.156	0.215
19-20	0.786	0.701	0.675	0.548	0.568	0.412	0.408	0.370	0.081	0.294	0.227	0.213	0.215
20-21	0.817	0.677	0.721	0.548	0.629	0.411	0.492	0.613	0.394	0.394	0.273	0.324	0.215
21-22	0.859	0.654	0.786	0.548	0.716	0.478	0.610	0.854	0.581	0.535	0.318	0.482	0.523
22-23	0.911	0.904	0.865	0.548	0.821	0.816	0.755	0.985	0.509	0.708	0.455	0.674	0.710
23-24	0.970	0.998	0.954	0.785	0.939	0.983	0.916	0.980	0.804	0.900	0.773	0.889	0.892

TABLE 4

Coefficients for Sinusoidal Hourly Demands,

For Phase Angle at Zero Hour.

Time, Hours				Values of k_s in $Q_d/\overline{Q}_d = 1 + k_s\ (a/\overline{Q}_d)\ (24/2\pi)$
Positive Values of k_s		Negative Values of k_s		
0-1	11-12	12-13	23-24	0.03407
1-2	10-11	13-14	22-23	0.09990
2-3	9-10	14-15	21-22	0.15892
3-4	8-9	15-16	20-21	0.20711
4-5	7-8	16-17	19-20	0.24118
5-6	6-7	17-18	18-19	0.25882

TABLE 5

Demand Variations for Districts From Which Data Was Used

District/City	Annual Average (Typical Day), mgd	Peak Day, mgd	Maximum Hour of Peak Day, mgd
Tri-Service, Philadelphia, Pa.(1)	29.2 ($a/\bar{Q}_d = 0.286$)	44.0 ($a/\bar{Q}_d = 0.232$)	58.2
Belmont H.S., Philadelphia, Pa.(1)	9.3 ($a/\bar{Q}_d = 0.353$)	13.9 ($a/\bar{Q}_d = 0.403$)	19.9
Champaign-Urbana, Illinois(2)	10.0 ($a/\bar{Q}_d = 0.331$)	16.1 ($a/\bar{Q}_d = 0.468$)	23.4
North High, Dallas, Texas(3)	10.4 ($a/\bar{Q}_d =$?)	28.1 ($a/\bar{Q}_d = 0.642$)	57.8
Towson Fourth Zone, Baltimore, Md.(4)	5.9 ($a/\bar{Q}_d = 0.642$)	13.45 ($a/\bar{Q}_d = 0.802$)	28.5
Royal Oak, Michigan(5)	13.0 ($a/\bar{Q}_d =$?)	26.4 ($a/\bar{Q}_d = 0.766$)	52.6
Los Angeles Co., W.W.D. No. 13(6)	1.70 ($a/\bar{Q}_d =$?)	3.25 ($a/\bar{Q}_d = 0.854$)	5.8

(1): Courtesy, Commissioner S. S. Baxter, Water Dept., Philadelphia, Penna.

(2): Courtesy, Mr. E. R. Healy, Vice Pres. & Mgr., Northern Illinois Water Corp., Champaign, Ill.

(3): Courtesy, Mr. D. A. Brock, Analyst & Statistician, Dept. of Water Works, Dallas, Texas. (Schedule for peak day appeared in Ref. 8).

(4): Courtesy, Mr. A. F. Boyles, Senior Engineer, Dept. of Public Works, Bureau of Water Supply, Baltimore, Maryland. (Schedule for peak day appeared in Ref. 9).

(5): Peak day schedule from Ref. 10.

(6): Courtesy, Mr. J. T. Rostron, Division Engineer, Water Works and Utilities Division, Department of Los Angeles County Engineers, Los Angeles, Calif.

TABLE 6

Coordinates for Pump Characteristics

(Double-suction, Single Stage Centrifugal)

Q_p/Q_{pd}	E_p/E_{pd} for Given N_s		
	N_s = 2200	N_s = 3000	N_s = 4000
0	1.185	1.342	1.521
0.20	1.178	1.297	1.450
0.40	1.166	1.246	1.370
0.60	1.138	1.187	1.273
0.80	1.088	1.108	1.156
0.90	1.049	1.057	1.085
1.00	1.000	1.000	1.000
1.10	1.942	0.929	0.896
1.20	0.870	0.843	0.765

TABLE 7

Maximum E_{pd} for Double-Suction Single-Stage Centrifugal Pumps, Pumping Clear Water at 85°F. at Sea Level, For Given N_s and Suction Lift/Head. (Hydraulic Institute Standards)

Suction Head/Lift	Maximum E_{pd}, Feet		
	N_s = 2200	N_s = 3000	N_s = 4000
25-ft. lift	87	52	32
20-ft. lift	140	83	51
15-ft. lift	190	112	69
10-ft. lift	240	142	87
5-ft. lift	285	167	103
0	340	197	120
5-ft. head	380	225	137
10-ft. head	425	250	155
15-ft. head	470	275	169

TABLE 8

Hypothetical Mean Depth of Storage Used, $\hat{y}$, Feet

Demand Schedule	$V/\overline{Q}_d \times 100$		
	10%	20%	40%
$a/\overline{Q}_d$ = 0.232			
Tri-Service Peak Day	11.5	5.7	
Sine Curve	9.2	4.6	
$a/\overline{Q}_d$ = 0.353			
Belmont H.S. Typical Day	15.6	7.8	
Sine Curve	14.0	7.0	
$a/\overline{Q}_d$ = 0.468			
Champaign-Urbana Peak Day	16.0	8.0	
Sine Curve	18.6	9.3	
$a/\overline{Q}_d$ = 0.642			
North High Peak Day		9.0	4.5
Towson Typical Day		13.9	6.9
Sine Curve		12.8	6.4
$a/\overline{Q}_d$ = 0.766			
Royal Oak Peak Day		13.1	6.6
Sine Curve		15.2	7.6
$a/\overline{Q}_d$ = 0.854			
Los Angeles Peak Day		17.3	8.6
Sine Curve		17.0	8.5

TABLE 9

Example of Constancy of $E_{pd} - Y + \hat{y}$

Sinusoidal Demand Schedules

$\Phi \bar{Q}_d^{\,2} = 40$

$V/\bar{Q}_d$ x 100	$a/\bar{Q}_d$	$E_{pd} - Y + \hat{y}$ (Feet)					
		n = 3			n = 4		
		N_s = 2,200	N_s = 3,000	N_s = 4,000	N_s = 2,200	N_s = 3,000	N_s = 4,000
20%	0.232	41.3	41.4	41.2	42.7	42.8	42.8
	0.353	42.9	43.0	42.9	45.6	45.6	45.7
	0.468	44.8	45.0	44.9	50.0	50.1	50.6
	0.642	49.3	49.3	49.8	59.2	58.1	61.3
	0.766	54.5	54.7	55.4	69.7	70.5	73.5
	0.854	60.2	60.2	62.5	80.2	81.5	90.1
10%	0.232	42.4	42.4	42.0	44.2	44.3	44.0
	0.353	44.6	44.9	44.7	48.0	48.2	48.1
	0.468	46.9	47.2	47.1	53.1	53.3	53.5
40%	0.642	47.7	47.6	48.3	56.8	55.5	59.0
	0.766	52.5	52.8	53.6	66.8	67.4	70.6
	0.854	57.8	57.9	60.5	74.3*	75.7	86.2*

(*: approximate runs)

TABLE 10

Example of Constancy of $E_{pd} - Y + \hat{y}$

$\Phi \bar{Q}_d^{\,2} = 40$

$a/\bar{Q}_d = 0.468$

n	N_s	E_{pd}, (Feet)	$\bar{Q}_d$ (= Q_{pd}) (mgd)	$E_{pd} - Y + \hat{y}$ (Feet)			
				$V/\bar{Q}_d$, 20%		$V/\bar{Q}_d$, 10%	
				Sine	Champaign-Urbana Peak Day	Sine	Champaign-Urbana Peak Day
3	2,200	243.3	20	44.8	46.3	47.0	47.8*
	2,200	268.2	10	44.8	46.4	46.9	47.9*
	2,200	425.8	20	44.7	46.7	46.4	48.0
	3,000	138.0	10	45.0	46.1	47.6	47.9*
	3,000	160.9	20	44.9	46.3	47.5	47.9*
	3,000	219.1	20	45.0	46.5	47.2	48.1*
	4,000	94.1	10	44.9	46.1	47.6	47.9*
	4,000	149.3	20	44.9	46.5	47.1	48.0*
	4,000	191.9	20	44.9	46.6	46.8	48.1
4	2,200	243.3	20	49.8	52.9	53.0	56.0
	2,200	268.2	10	50.0	53.2	53.1	56.3
	2,200	425.8	20	51.0	55.4	53.5	58.1
	3,000	138.0	10	49.3	51.4	52.9	54.8
	3,000	160.9	20	49.5	51.9	53.0	55.2
	3,000	219.1	20	50.1	53.1	53.3	56.1
	4,000	94.1	10	49.3	51.5	52.9	54.9
	4,000	149.3	20	50.1	53.2	53.2	56.2
	4,000	191.9	20	50.6	54.4	53.5	57.2

(*: approximate runs)

TABLE 11

Range of Q_p/Q_d For Storage

Equalization Computed Characteristics

Identification	Maximum Q_p/Q_d N_s = 2200	N_s = 3000	N_s = 4000	Minimum Q_p/Q_d N_s = 2200	N_s = 3000	N_s = 4000
Tri-Service	1.51	1.51	1.51	0.72	0.72	0.74
Sine, $a/\overline{Q}_d$ = 0.232	1.30	1.30	1.30	0.81	0.81	0.81
Belmont	1.83	1.83	1.83	0.72	0.70	0.72
Sine, $a/\overline{Q}_d$ = 0.353	1.54	1.54	1.54	0.74	0.74	0.74
Champaign-Urbana	2.79	2.79	2.79	0.70	0.70	0.70
Sine, $a/\overline{Q}_d$ = 0.468	1.87	1.87	1.87	0.68	0.68	0.68
North High	3.43	3.45	3.41	0.49	0.49	0.49
Towson	12.3	12.3	12.3	0.58	0.58	0.58
Sine, $a/\overline{Q}_d$ = 0.642	2.75	2.75	2.75	0.61	0.61	0.61
Royal Oak	4.40	4.40	4.40	0.51	0.51	0.51
Sine, $a/\overline{Q}_d$ = 0.766	4.13	4.14	4.14	0.57	0.57	0.57
Los Angeles Co.	4.90	4.79	4.75	0.55	0.54	0.57
Sine, $a/\overline{Q}_d$ = 0.854	6.55	6.45	6.45	0.54	0.54	0.54

TABLE 12

Comparison of Hypothetical Maximum Storage Volume Used as $U/\bar{Q}_d$ in mg/mgd for Q_p = Constant = $\bar{Q}_d$ Versus Computed $U/\bar{Q}_d$ for Frictionless Network With $\Phi = 0$.

$a/\bar{Q}_d$	Hypothetical $U/\bar{Q}_d$ = 0.318 $a/\bar{Q}_d$, for Q_p = Constant = $\bar{Q}_d$	Demand Schedule	$U/\bar{Q}_d$, For $\Phi = 0$, Computed: N_s = 2200, For $V/\bar{Q}_d$ × 100 = 10%	20%	40%	N_s = 3000, For $V/\bar{Q}_d$ × 100 = 10%	20%	40%	N_s = 4000, For $V/\bar{Q}_d$ × 100 = 10%	20%	40%
0.232	0.074	Sine Tri-Service	0.0701 0.0692	0.0725 0.0726	-- --	0.0705 0.0697	0.0725 0.0728	-- --	0.0722 0.0722	0.0732 0.0733	-- --
0.353	0.112	Sine Belmont	0.1045 0.1078	0.1099 0.1128	-- --	0.1072 0.1100	0.1106 0.1129	-- --	0.1070 0.1103	0.1100 0.1128	-- --
0.468	0.149	Sine Cham.-Urb.	0.1428 0.1471	0.1465 0.1496	-- --	0.1424 0.1476	0.1465 0.1497	-- --	0.1449 0.1488	0.1474 0.1499	-- --
0.642	0.204	Sine North High Towson	-- -- --	0.2006 0.2060 0.2007	0.2033 0.2057 0.2037	-- -- --	0.1995 0.2060 0.2012	0.2026 0.2056 0.2038	-- -- --	0.2021 0.2060 0.2026	0.2039 0.2053 0.2041
0.766	0.244	Sine Royal Oak	-- --	0.2392 0.2455	0.2424 0.2460	-- --	0.2397 0.2457	0.2426 0.2459	-- --	0.2409 0.2461	0.2431 0.2456
0.854	0.272	Sine L.A. Co.	-- --	0.2666 0.2685	0.2702 0.2711	-- --	0.2669 0.2689	0.2705 0.2712	-- --	0.2697 0.2708	0.2713 0.2715

TABLE 13

$U/\overline{Q}_d$ Comparison, Belmont H.S. Typical Day;

$N_s = 3,000$

n	$V/\overline{Q}_d$ x 100 (mg/mgd)	$\frac{\Phi \overline{Q}_d^2}{E_{pd}}$	$U/\overline{Q}_d$ (mg/mgd)	$\Phi \overline{Q}_d^2$ (feet)	$E_{pd} - Y + \hat{Y}$ (Feet)	$\overline{Q}_d$ (mgd)	E_{pd} (Feet)
4	20%	0.116	0.0835	16	20.4	10	138.1
4	20%	0.114	0.0829	8	11.1	10	70.4
3	20%	0.232	0.0901	32	35.2	10	138.1
3	20%	0.227	0.0899	16	18.3	10	70.4
3	10%	0.456	0.0837	100	106.1	20	219.1
3	10%	0.463	0.0837	64	70.6	10	138.1
4	20%	0.913	0.0613	200	215.4	20	219.1
4	20%	0.894	0.0606	100	109.5	20	111.8

TABLE 14

Example of Sine Versus Actual Demands, $U/\overline{Q}_d$

$N_s = 4,000$

Demand	n	$V/\overline{Q}_d$ x 100 (mg/mgd)	$\frac{\Phi\overline{Q}_d^{\,2}}{E_{pd}}$	$U/\overline{Q}_d$ (mg/mgd)	$\Phi\overline{Q}_d^{\,2}$ (feet)	$E_{pd} - Y + \zeta$ (Feet)	$\overline{Q}_d$ (mgd)	E_{pd} (Feet)
Champaign-Urbana Peak Day	4 4	20% 20%	0.052 0.053	0.1245 0.1238	10 5	16.7 9.0	20 10	191.9 94.1
	3 3	10% 10%	0.417 0.425	0.1126 0.1122	80 40	92.4 47.9	20 10	191.9 94.1
	4 4	10% 10%	0.417 0.425	0.0881 0.0881	80 40	103.4 54.9	20 10	191.9 94.1
$a/\overline{Q}_d$ = 0.468	4 4	20% 20%	0.052 0.053	0.1316 0.1295	10 5	14.4 8.2	20 10	191.9 91.1
	3 3	10% 10%	0.417 0.425	0.1177 0.1159	80 40	90.0 47.6	20 10	191.9 94.1
	4 4	10% 10%	0.417 0.425	0.0975 0.0965	80 40	98.8 52.9	20 10	191.9 94.1

TABLE 15

EFFECT OF VARIABLE SUCTION WATER LEVEL, FRICTIONLESS NETWORK

Sinusoidal Demand Schedule

$\Phi\bar{Q}_d^{\,2} = 0$

$a/\bar{Q}_d$	$V/\bar{Q}_d$ x 100	N_s	a_s, Ft.	$U/\bar{Q}_d$ (mg/mgd)
0.353	20%	2,200	0	0.1099
		2,200	2.5	0.1107
		2,200	5.0	0.1116
		3,000	0	0.1106
		3,000	2.5	0.1109
		3,000	5.0	0.1117
		4,000	0	0.1100
		4,000	2.5	0.1115
		4,000	5.0	0.1119
			Hypothetical:	0.112
0.766	40%	2,200	0	0.2424
		2,200	2.5	0.2429
		2,200	5.0	0.2434
		3,000	0	0.2426
		3,000	2.5	0.2430
		3,000	5.0	0.2434
		4,000	0	0.2431
		4,000	2.5	0.2433
		4,000	5.0	0.2436
			Hypothetical:	0.244

TABLE 16

EFFECT OF VARIABLE SUCTION WATER LEVEL

Sinusoidal Demand Schedule for $a/\overline{Q}_d$ = 0.353;

$V/\overline{Q}_d \times 100$ = 20% ($\hat{y}$ = 7.0 Ft.); $\Phi\overline{Q}_d^{\,2}$ = 40 (feet)

N_s	$\overline{Q}_d$, mgd	E_{pd}, Ft.	$\Phi\overline{Q}_d^{\,2}/E_{pd}$	n	a_s, Ft.	$E_{pd} - Y + \hat{y}$, Ft.	$U/\overline{Q}_d$ (mg/mgd)
2,200	20	243.3	0.164	2	0	40.0	0.1110
				2	2.5	39.9	0.1121
				2	5.0	39.9	0.1125
				2.5	0	41.3	0.1018
				2.5	2.5	41.3	0.1021
				2.5	5.0	41.2	0.1024
				3	0	42.8	0.0932
				3	2.5	42.8	0.0934
				3	5.0	42.8	0.0937
				4	0	45.7	0.0796
				4	2.5	45.7	0.0798
				4	5.0	45.7	0.0799
3,000	20	219.1	0.183	2	0	40.0	0.1118
				2	2.5	40.0	0.1121
				2	5.0	39.9	0.1124
				2.5	0	41.4	0.1022
				2.5	2.5	41.3	0.1025
				2.5	5.0	41.3	0.1027
				3	0	43.0	0.0938
				3	2.5	42.9	0.0942
				3	5.0	42.8	0.0944
				4	0	45.6	0.0812
				4	2.5	45.9	0.0807
				4	5.0	45.9	0.0809
4,000	20	191.9	0.208	2	0	40.0	0.1112
				2	2.5	39.9	0.1122
				2	5.0	39.9	0.1125
				2.5	0	41.3	0.1038
				2.5	2.5	41.2	0.1040
				2.5	5.0	41.0	0.1042
				3	0	42.8	0.0965
				3	2.5	42.8	0.0967
				3	5.0	42.7	0.0968
				4	0	46.1	0.0842
				4	2.5	46.1	0.0843
				4	5.0	46.0	0.0845

TABLE 17

EFFECT OF VARIABLE SUCTION WATER LEVEL

Sinusoidal Demand Schedule for $a/\bar{Q}_d$ = 0.766;

$V/\bar{Q}_d$ x 100 = 40% ($\hat{y}$ = 7.6 Ft.); $\Phi\bar{Q}_d^{\,2}$ = 40 (feet)

N_s	$\bar{Q}_d$, mgd	E_{pd}, Ft.	$\Phi\bar{Q}_d^{\,2}/E_{pd}$	n	a_s, Ft.	$E_{pd} - Y + \hat{y}$, Ft.	$U/\bar{Q}_d$ (mg/mgd)
2,200	20	243.3	0.164	2	0	39.8	0.2441
				2	2.5	39.7	0.2443
				2	5.0	39.7	0.2445
				2.5	0	45.6	0.2173
				2.5	2.5	45.5	0.2175
				2.5	5.0	45.5	0.2176
				3	0	52.5	0.1931
				3	2.5	52.5	0.1932
				3	5.0	52.5	0.1933
				4	0	66.8	0.1557
				4	2.5	66.8	0.1554
				4	5.0	65.8*	0.1567*
3,000	20	219.1	0.183	2	0	39.8	0.2441
				2	2.5	39.8	0.2443
				2	5.0	39.7	0.2445
				2.5	0	45.7	0.2183
				2.5	2.5	45.7	0.2184
				2.5	5.0	45.7	0.2186
				3	0	52.8	0.1952
				3	2.5	52.8	0.1953
				3	5.0	52.8	0.1954
				4	0	67.4	0.1590
				4	2.5	67.4	0.1588
				4	5.0	67.0*	0.1591*
4,000	20	191.9	0.208	2	0	39.7	0.2443
				2	2.5	39.7	0.2444
				2	5.0	39.6	0.2446
				2.5	0	45.7	0.2220
				2.5	2.5	45.7	0.2221
				2.5	5.0	45.6	0.2221
				3	0	53.6	0.2006
				3	2.5	53.6	0.2006
				3	5.0	53.6	0.2007
				4	0	70.6	0.1656
				4	2.5	70.5	0.1654
				4	5.0	70.5	0.1652

(*: approximate run)

TABLE 18

EFFECT OF VARIABLE SUCTION WATER LEVEL

Sinusoidal Demand Schedule for $a/\overline{Q}_d$ = 0.766;

$V/\overline{Q}_d \times 100$ = 40% ($\hat{y}$ = 7.6 Ft.); $\Phi\overline{Q}_d^{\,2}$ = 20 (feet)

N_s	$\overline{Q}_d$, mgd	E_{pd}, Ft.	$\Phi\overline{Q}_d^{\,2}/E_{pd}$	n	a_s, Ft.	$E_{pd} - Y + \hat{y}$, Ft.	$U/\overline{Q}_d$ (mg/mgd)
2,200	20	243.3	0.082	2	0	19.9	0.2438
				2	2.5	19.8	0.2441
				2	5.0	19.8	0.2444
				2.5	0	23.2	0.2262
				2.5	2.5	23.1	0.2265
				2.5	5.0	23.1	0.2267
				3	0	27.9	0.2079
				3	2.5	27.8	0.2081
				3	5.0	27.8	0.2083
				4	0	39.0	0.1747
				4	2.5	38.9	0.1744
				4	5.0	38.9	0.1743
3,000	20	219.1	0.091	2	0	19.9	0.2437
				2	2.5	19.9	0.2441
				2	5.0	19.8	0.2443
				2.5	0	23.3	0.2271
				2.5	2.5	23.2	0.2273
				2.5	5.0	23.2	0.2275
				3	0	28.1	0.2096
				3	2.5	28.0	0.2098
				3	5.0	28.0	0.2099
				4	0	39.3	0.1777
				4	2.5	39.3	0.1775
				4	5.0	39.3	0.1774
4,000	20	191.9	0.104	2	0	19.8	0.2442
				2	2.5	19.7	0.2443
				2	5.0	19.7	0.2445
				2.5	0	23.2	0.2301
				2.5	2.5	23.1	0.2302
				2.5	5.0	23.1	0.2304
				3	0	28.3	0.2147
				3	2.5	28.3	0.2148
				3	5.0	28.3	0.2149
				4	0	41.3	0.1845
				4	2.5	41.3	0.1844
				4	5.0	41.3	0.1845

TABLE 19

EFFECT OF VARIABLE SUCTION WATER LEVEL

Sinusoidal Demand Schedule for $a/\overline{Q}_d$ = 0.766;

$V/\overline{Q}_d$ x 100 = 40% ($\hat{y}$ = 7.6 Ft.); $\Phi\overline{Q}_d^{\,2}$ = 20 (feet)

N_s	$\overline{Q}_d$, mgd	E_{pd}, Ft.	$\Phi\overline{Q}_d^{\,2}/E_{pd}$	n	a_s, Ft.	$E_{pd} - Y + \hat{y}$, Ft.	$U/\overline{Q}_d$ (mg/mgd)
2,200	10	153.3	0.131	2.5	0	23.3	0.2201
				2.5	2.5	23.2	0.2201
				2.5	5.0	23.2	0.2205
				3	0	27.4	0.1977
				3	2.5	27.3	0.1980
				3	5.0	27.3	0.1983
				4	0	36.1	0.1621
				4	2.5	36.0	0.1618
				4	5.0	36.0	0.1614
3,000	10	138.0	0.145	2.5	0	23.3	0.2213
				2.5	2.5	23.3	0.2213
				2.5	5.0	23.2	0.2216
				3	0	27.9	0.2002
				3	2.5	27.5	0.1999
				3	5.0	27.5	0.2002
				4	0	36.3	0.1656
				4	2.5	36.3	0.1650
				4	5.0	36.3	0.1647
4,000	10	120.9	0.165	2.5	0	23.3	0.2247
				2.5	2.5	23.2	0.2247
				2.5	5.0	23.2	0.2250
				3	0	27.8	0.2052
				3	2.5	27.8	0.2054
				3	5.0	27.7	0.2056
				4	0	38.0	0.1721
				4	2.5	38.0	0.1718
				4	5.0	38.0	0.1716

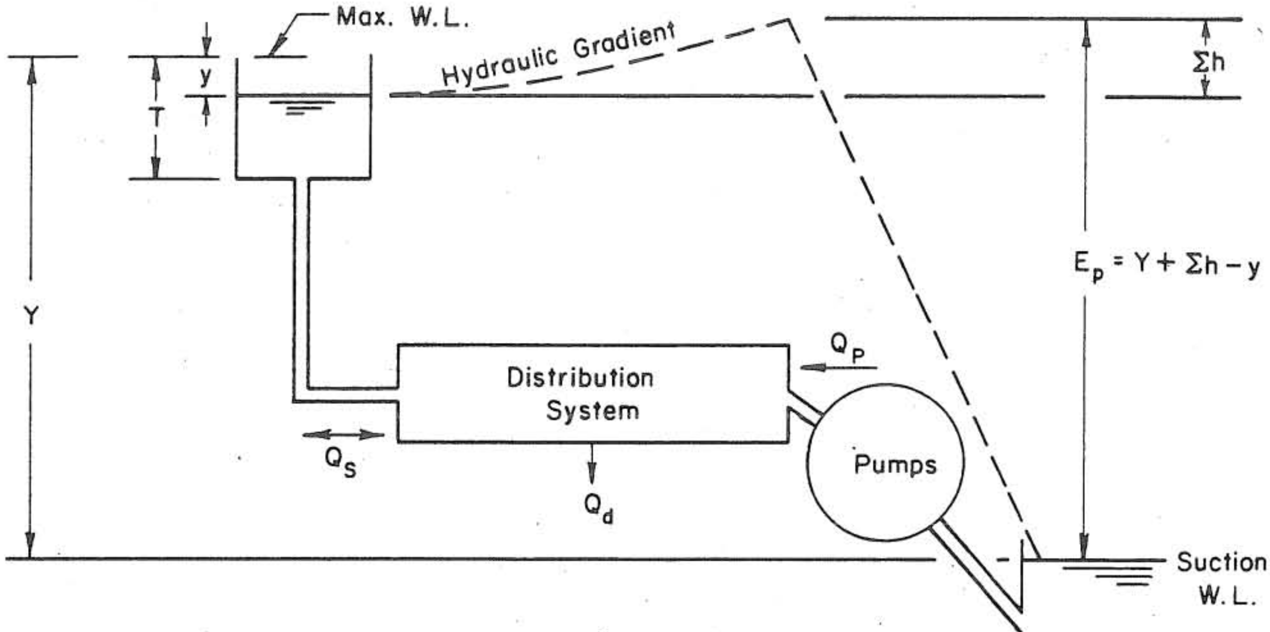


FIGURE Ia—SCHEMATIC OF SYSTEM.

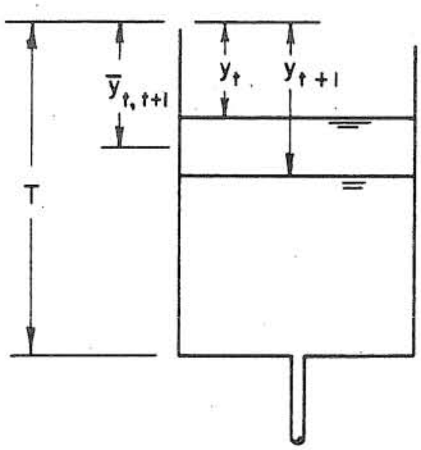


FIGURE Ib—AVERAGE STORAGE WATER LEVEL, DETAIL.

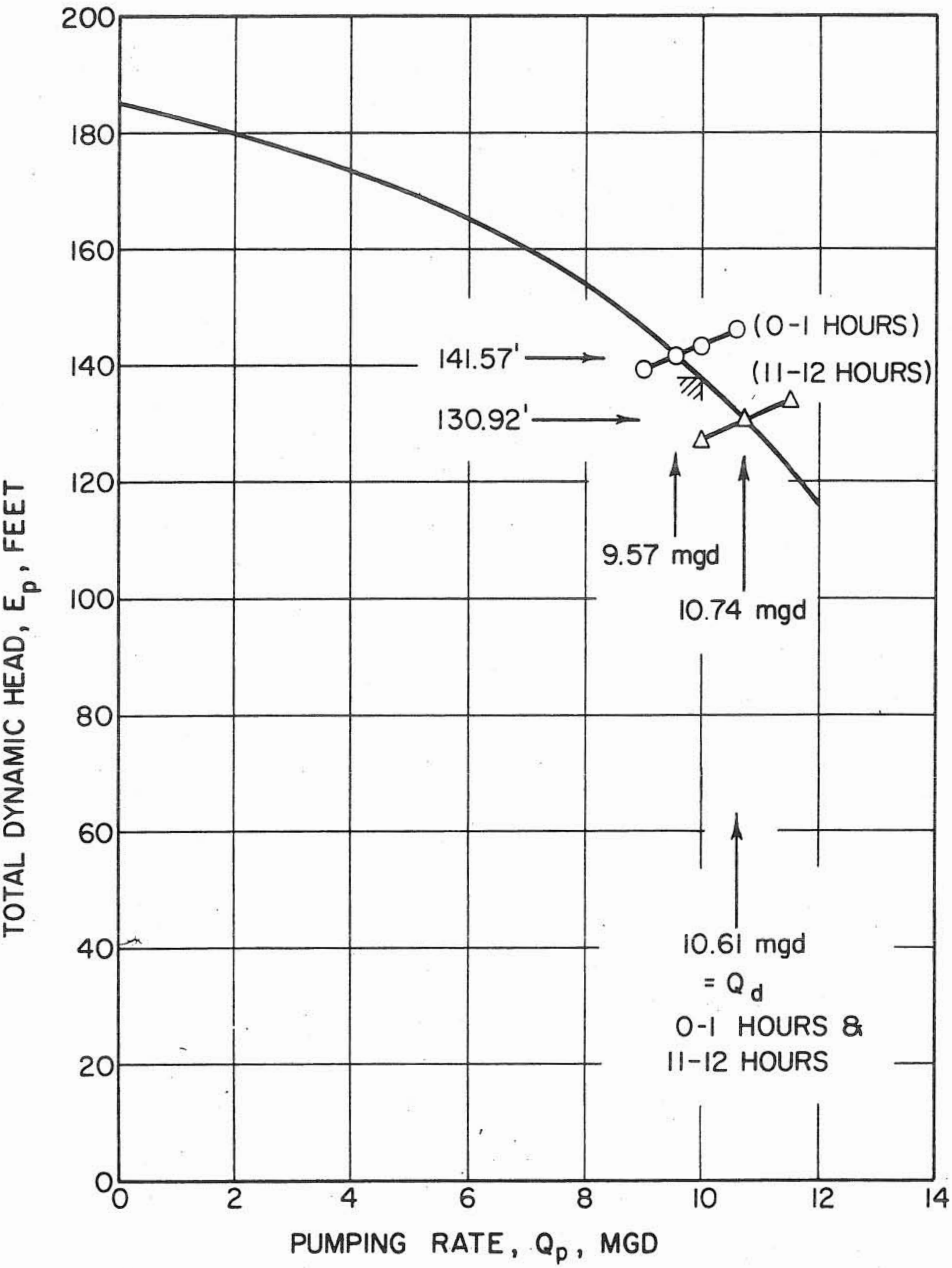


FIGURE 2 - EXAMPLE OF SYSTEM BALANCES FOR TABLE I.

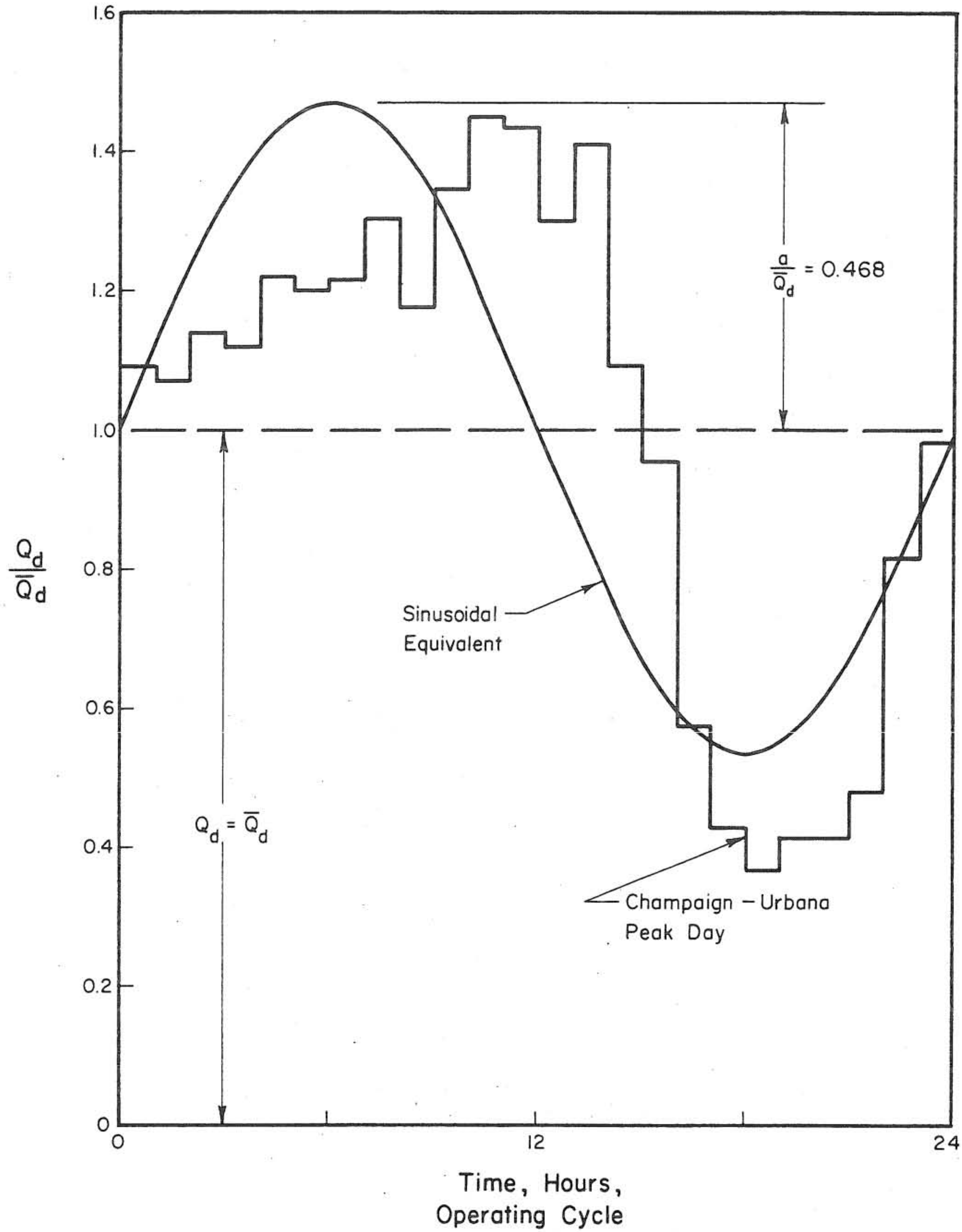


FIGURE 3—EXAMPLE OF ACTUAL VERSUS SINUSOIDAL-EQUIVALENT DEMAND SCHEDULE.

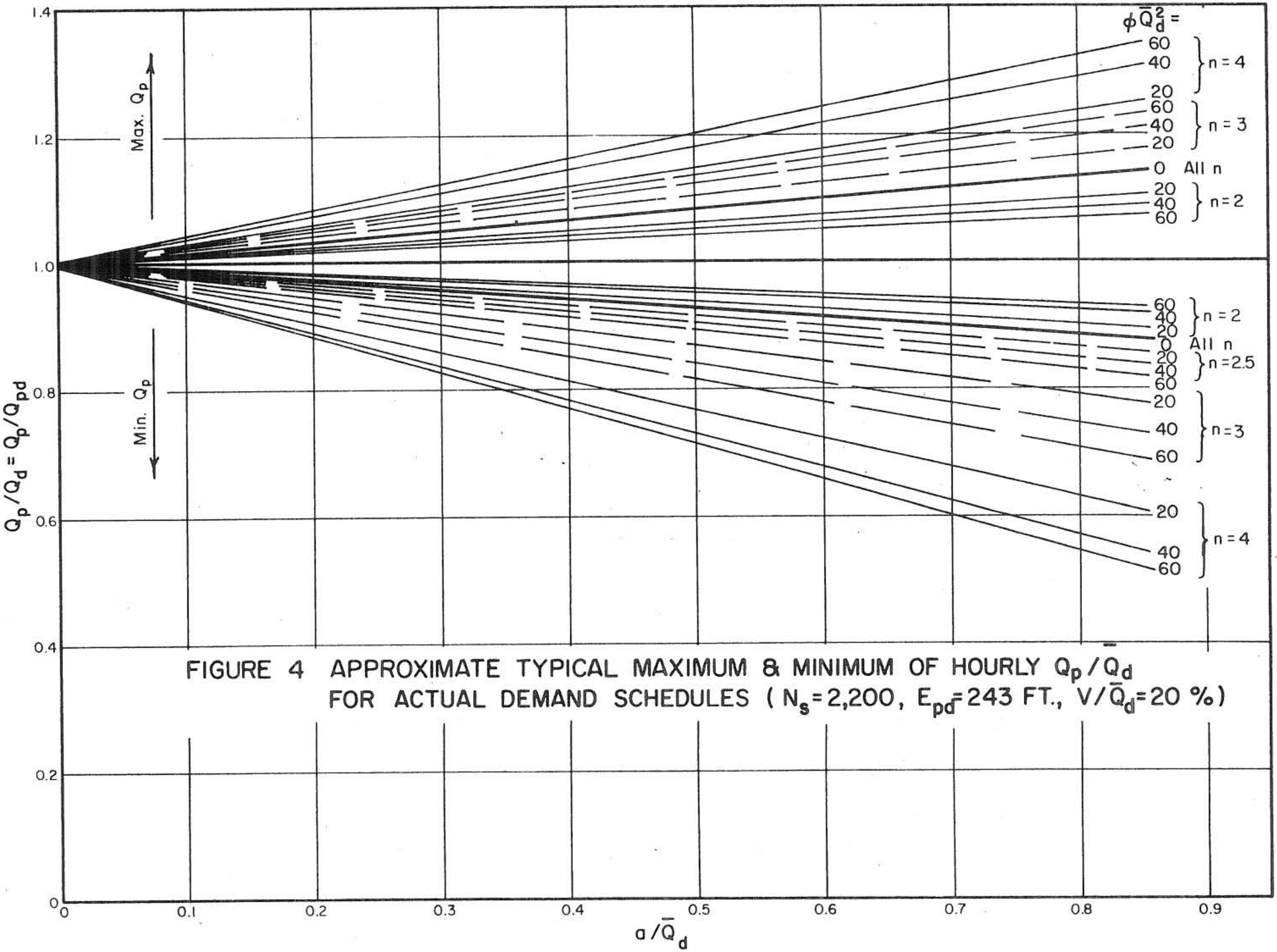


FIGURE 4 APPROXIMATE TYPICAL MAXIMUM & MINIMUM OF HOURLY $Q_p/\bar{Q}_d$ FOR ACTUAL DEMAND SCHEDULES (N_s = 2,200, E_{pd} = 243 FT., $V/\bar{Q}_d$ = 20 %)

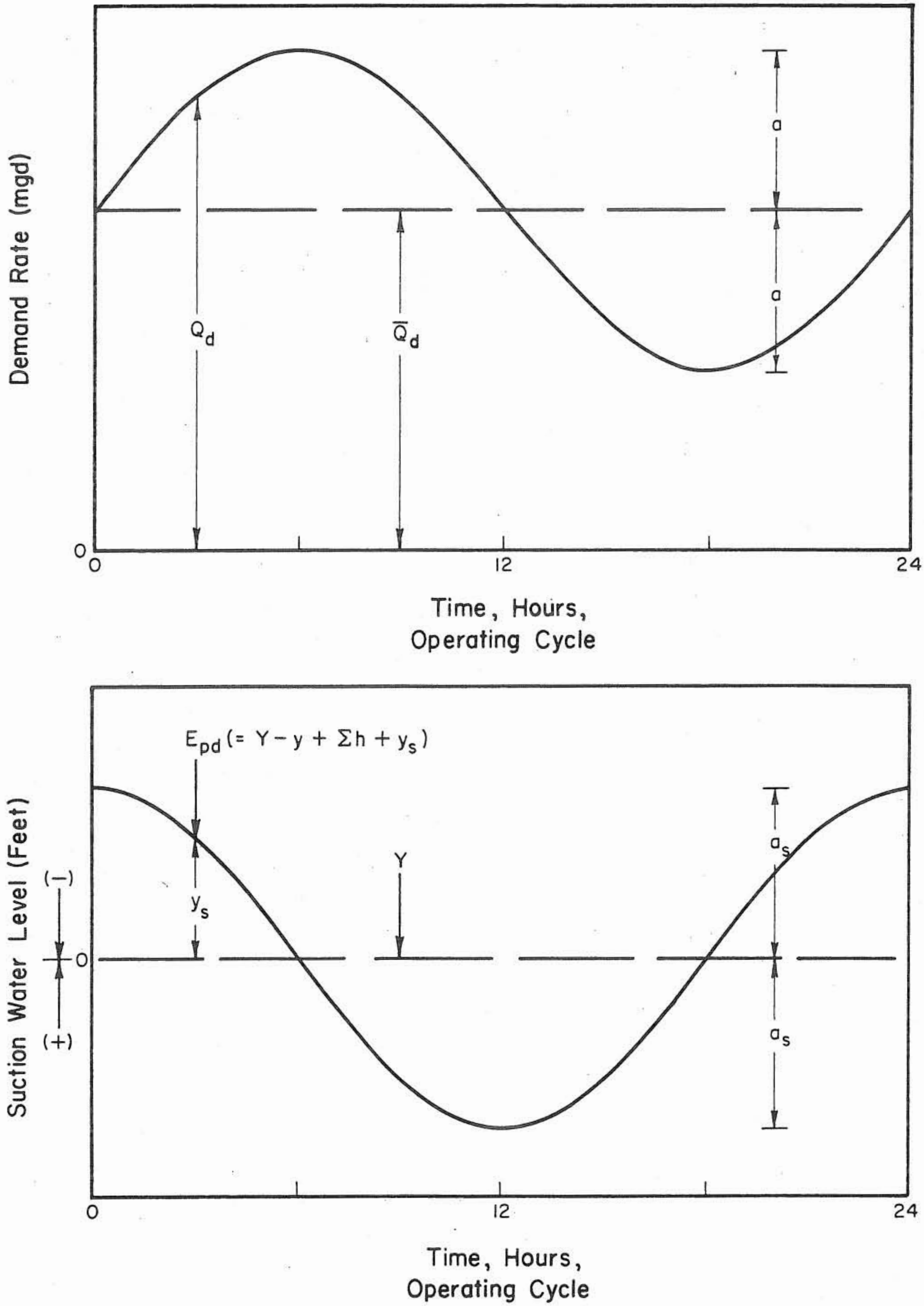


FIGURE 5-VARIABLE SUCTION CONDITIONS.

APPENDIX I

LIST OF FIGURES - COMPUTER RESULTS

$E_{pd} - Y + \hat{y}$ versus $\Phi\overline{Q_d}^2$

FIGURE TR-1

$a/\bar{Q}_d = 0.232$

$N_s = 2200;\ 3000;\ 4000$

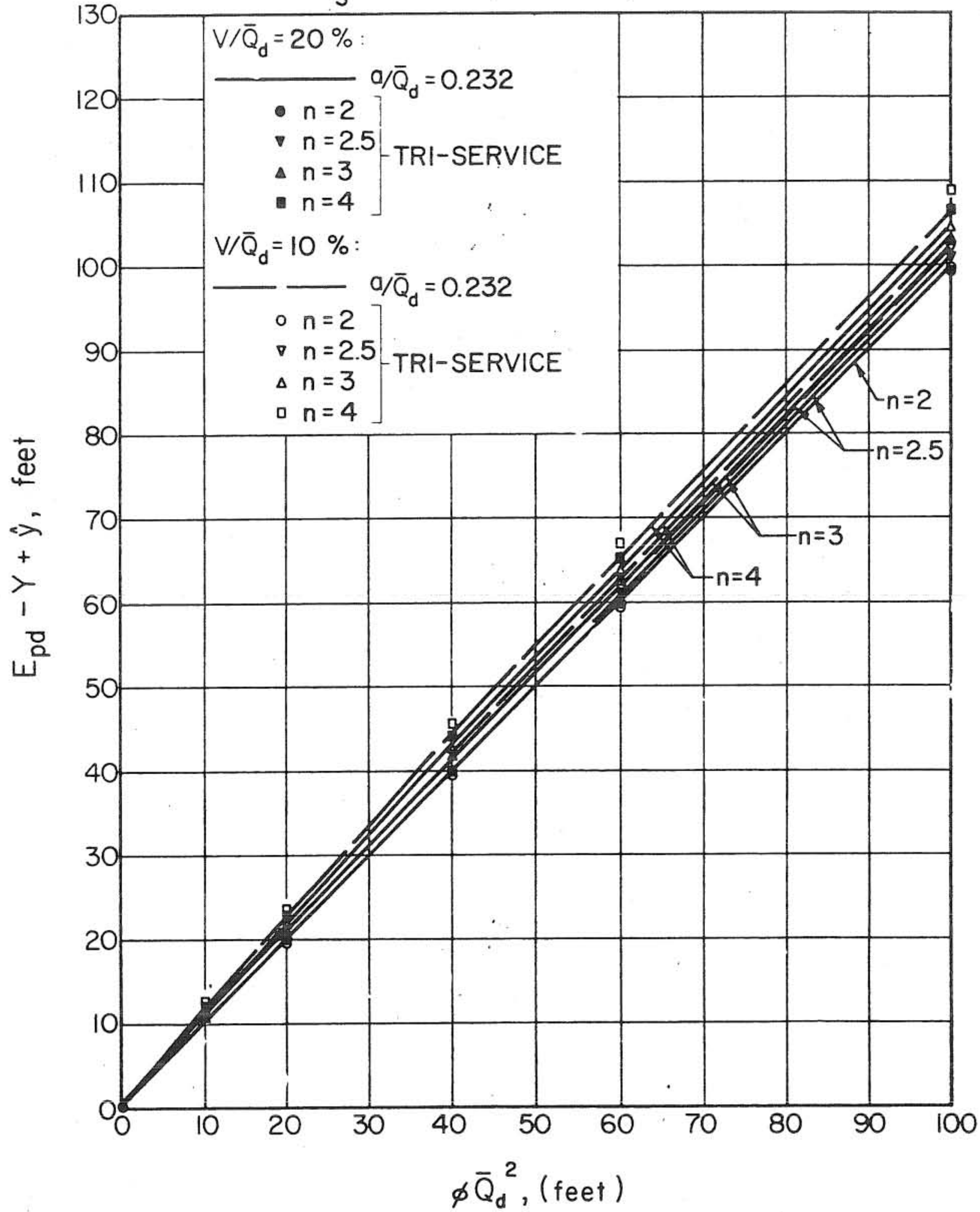


FIGURE B-1

$a/\bar{Q}_d = 0.353$

$N_s = 2200;\ 3000;\ 4000$

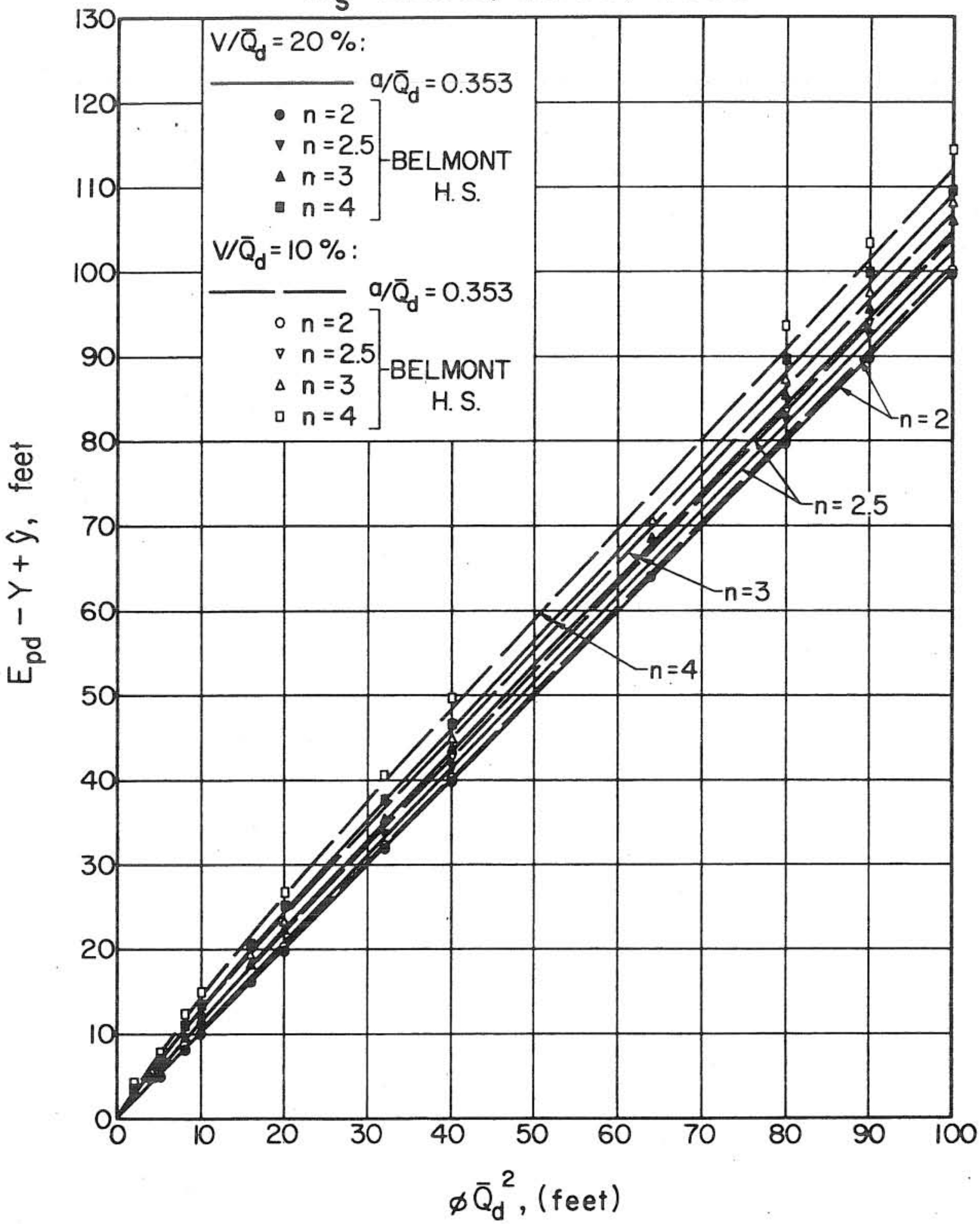


FIGURE CU-1

$a/\bar{Q}_d = 0.468$

$N_s = 2200;\ 3000;\ 4000$

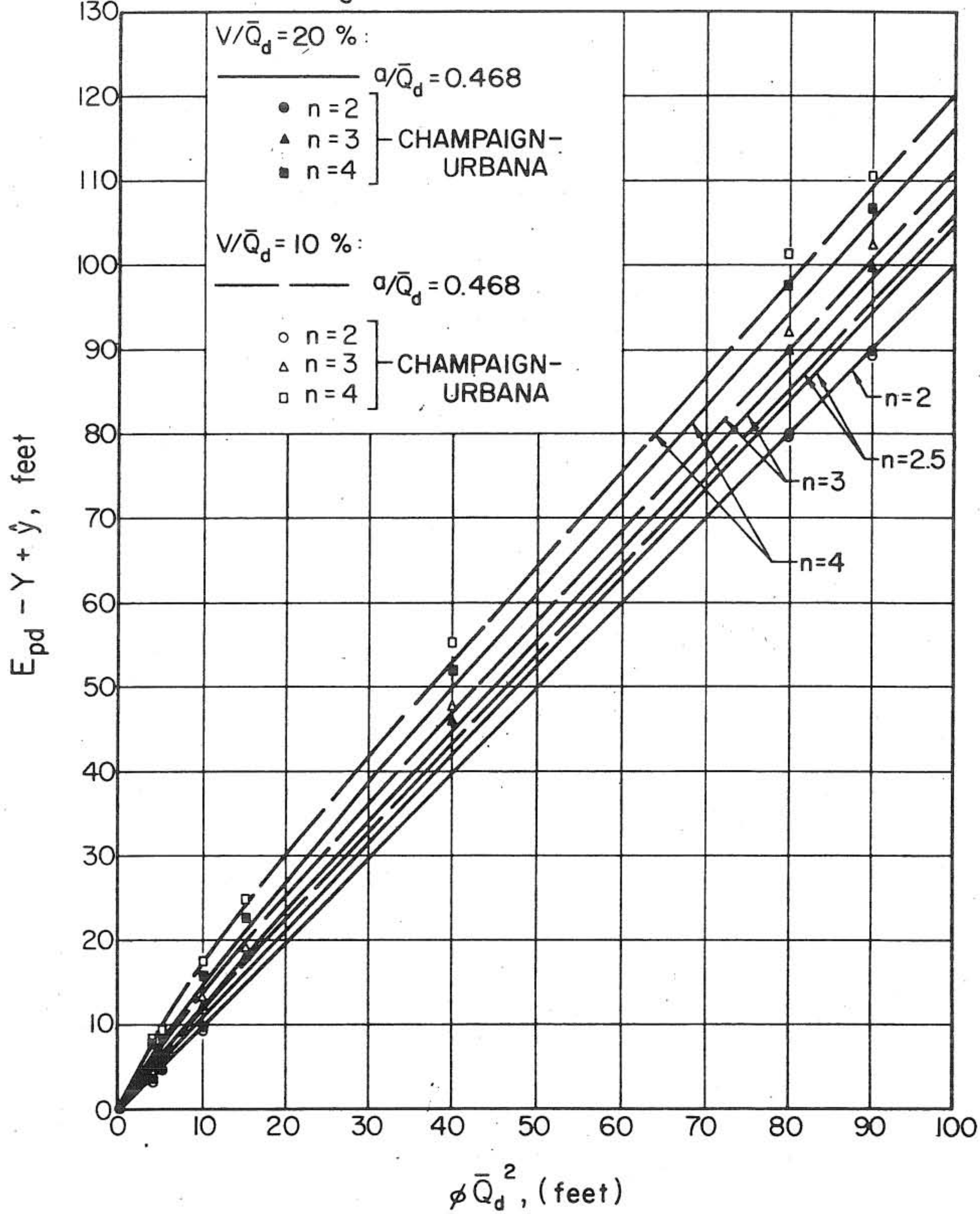


FIGURE NH-1

$a/\bar{Q}_d = 0.642$

$N_s = 2200;\ 3000;\ 4000$

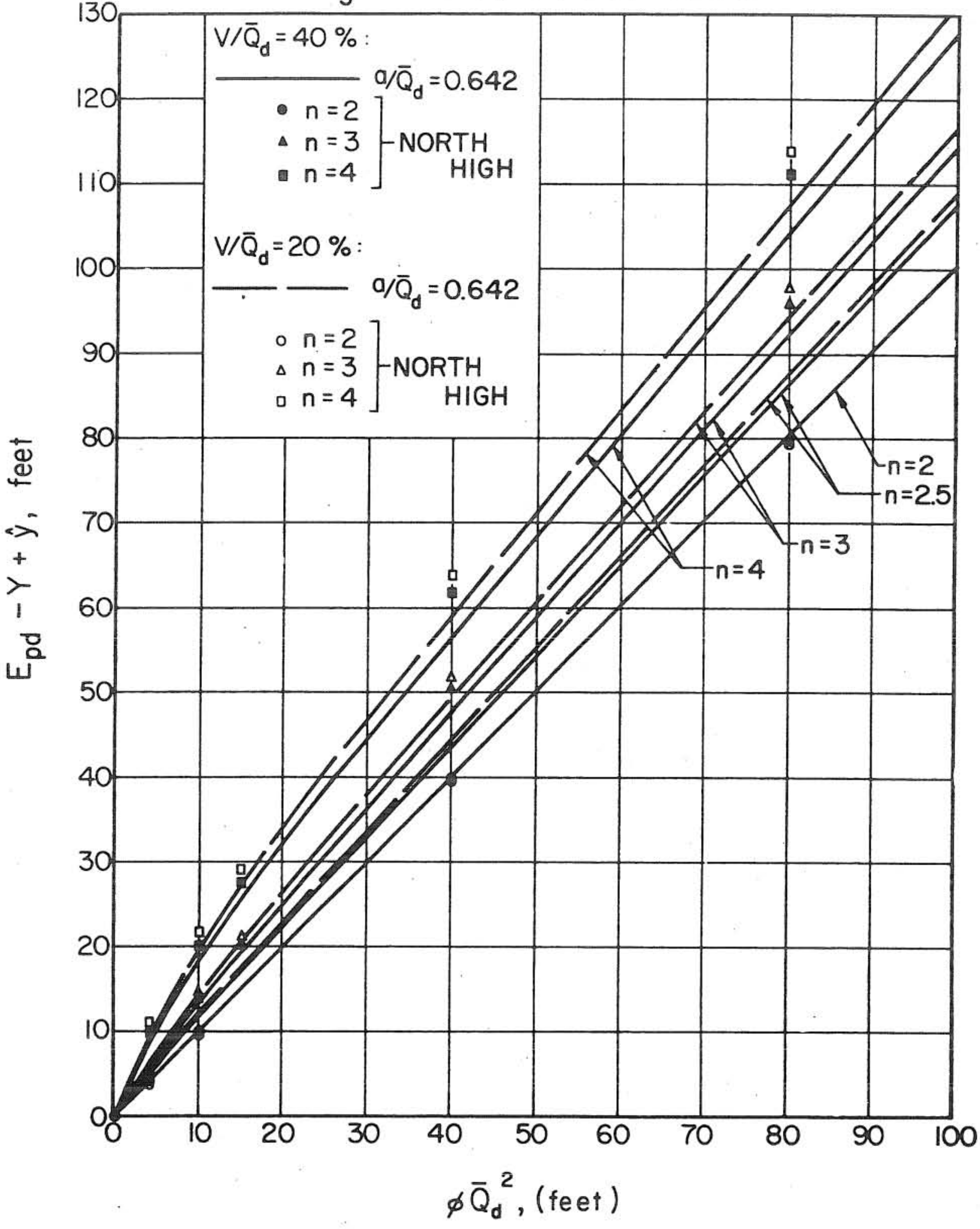


FIGURE TO-1

$a/\bar{Q}_d = 0.642$

$N_s = 2200;\ 3000;\ 4000$

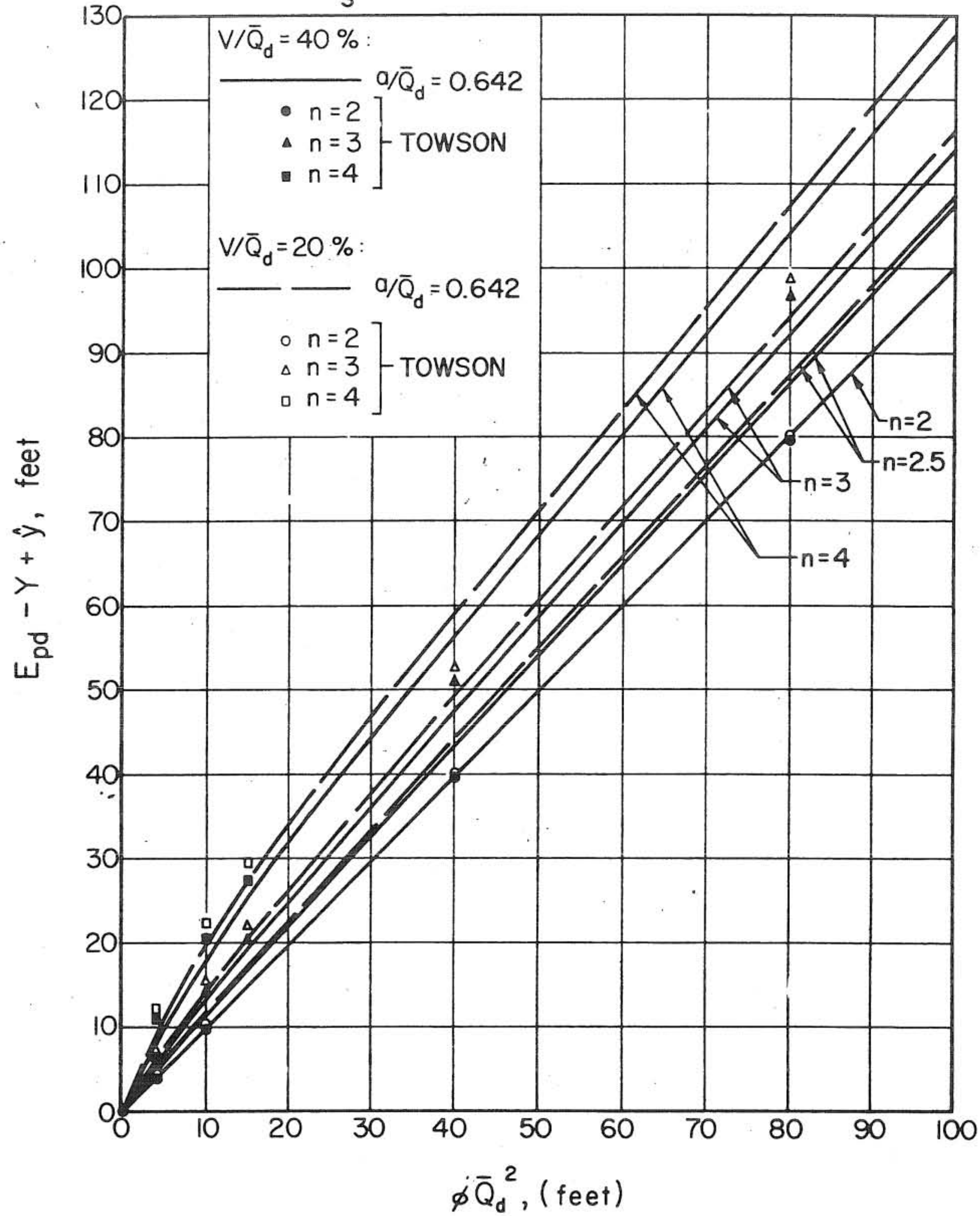


FIGURE RO-1

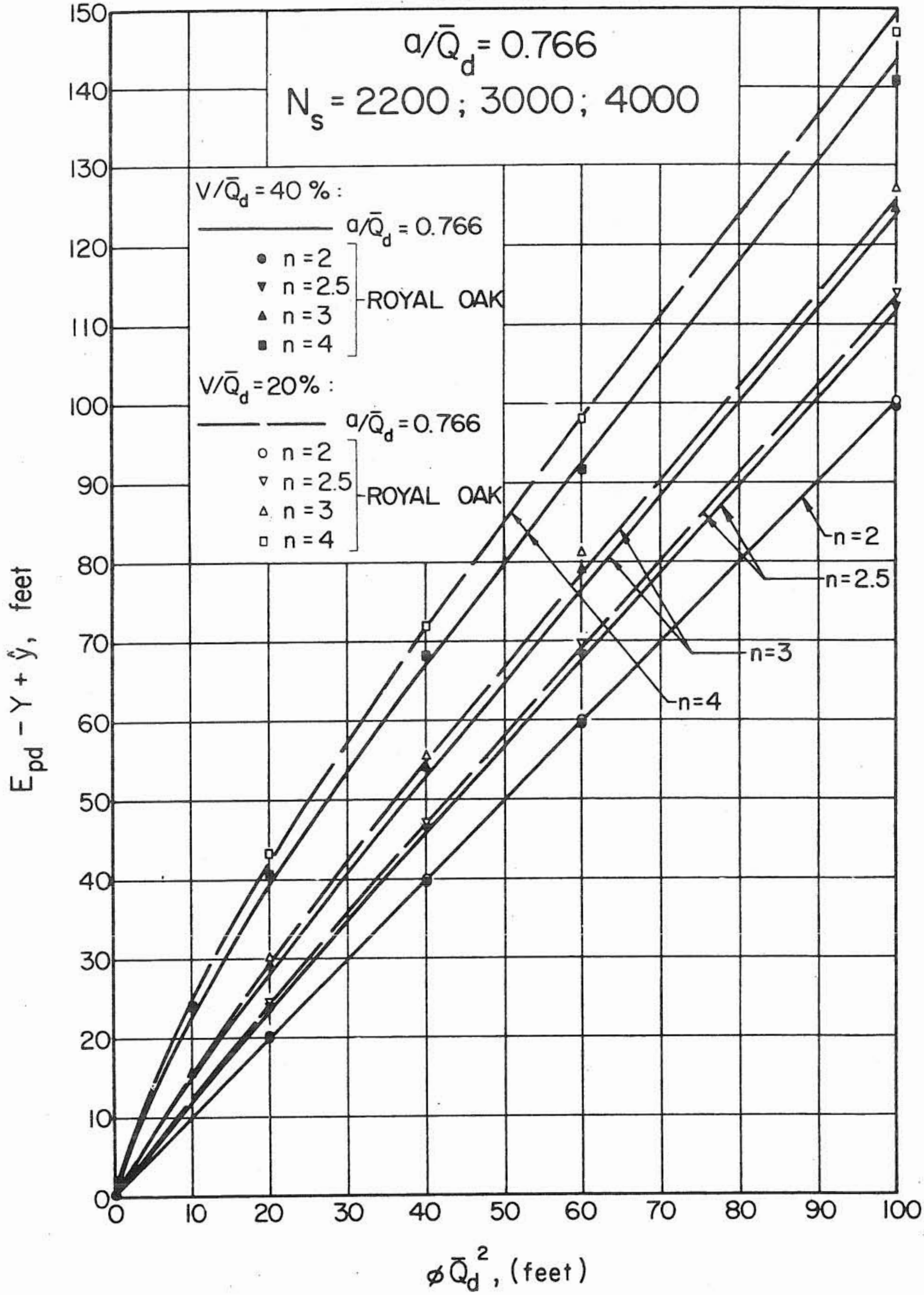
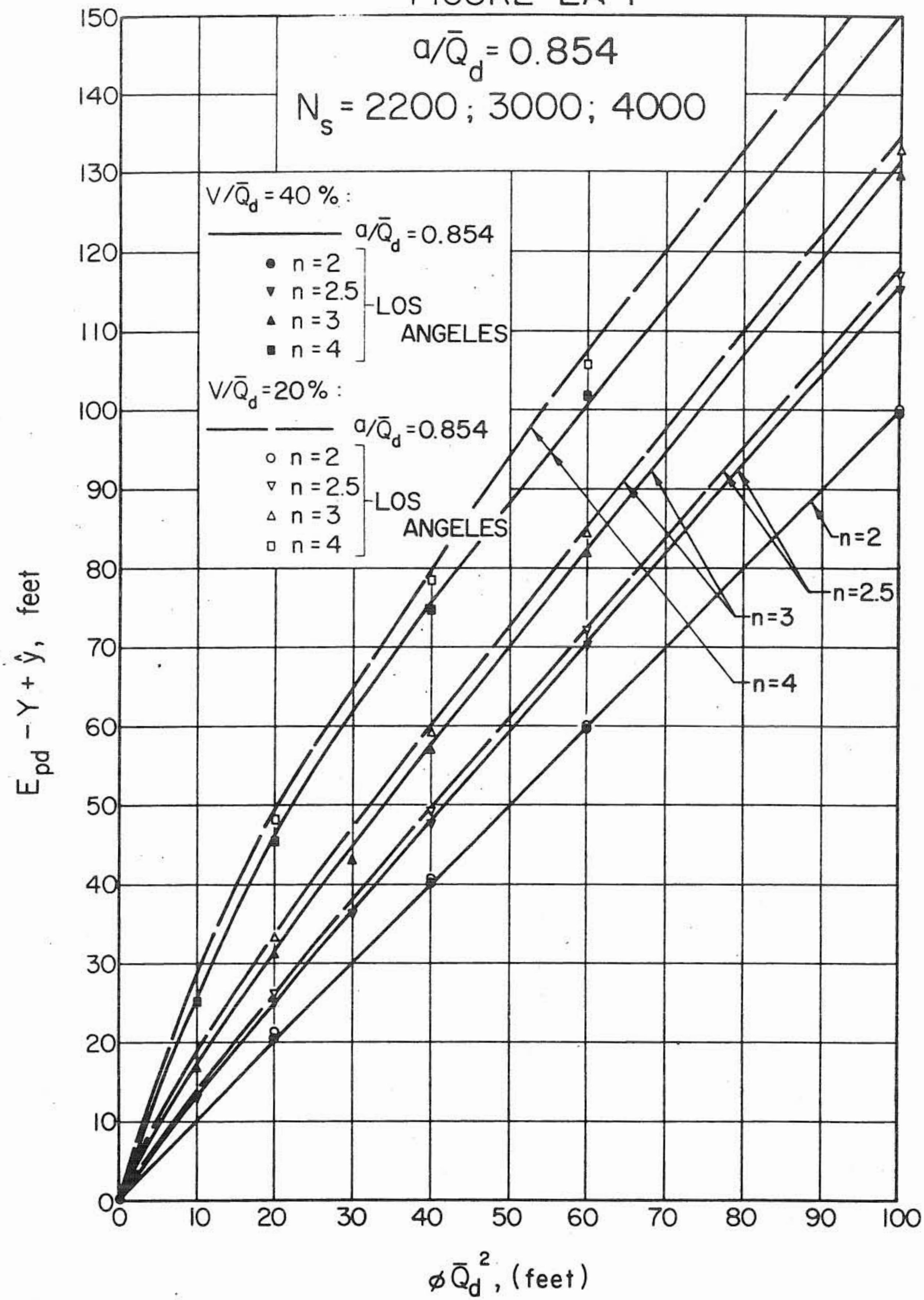

$a/\bar{Q}_d = 0.766$
$N_s = 2200;\ 3000;\ 4000$
$V/\bar{Q}_d = 40\%$:
$a/\bar{Q}_d = 0.766$
n = 2
n = 2.5
n = 3
n = 4
ROYAL OAK
$V/\bar{Q}_d = 20\%$:
$a/\bar{Q}_d = 0.766$
n = 2
n = 2.5
n = 3
n = 4
ROYAL OAK
n=2
n=2.5
n=3
n=4
$E_{pd} - Y + \hat{y}$, feet
$\phi \bar{Q}_d^2$, (feet)

FIGURE LA-1



a/Q̄d = 0.854
Ns = 2200 ; 3000; 4000
V/Q̄d = 40 % :
a/Q̄d = 0.854
n = 2
n = 2.5
n = 3
n = 4
LOS ANGELES
V/Q̄d = 20 % :
a/Q̄d = 0.854
n = 2
n = 2.5
n = 3
n = 4
LOS ANGELES
n=2
n=2.5
n=3
n=4
Epd − Y + ŷ, feet
φQ̄d², (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150

APPENDIX II

LIST OF FIGURES - COMPUTER RESULTS

$U/\overline{Q_d}$ versus $\Phi\overline{Q_d}^2/E_{pd}$

	Figure Number		
	N_s = 2,200	N_s = 3,000	N_s = 4,000
Tri-Service	TR-2	TR-3	TR-4
Belmont	B-2	B-3	B-4
Champaign-Urbana	CU-2	CU-3	CU-4
North High	NH-2	NH-3	NH-4
Towson	TO-2	TO-3	TO-4
Royal Oak	RO-2	RO-3	RO-4
Los Angeles	LA-2	LA-3	LA-4

FIGURE TR-2

$a/\bar{Q}_d = 0.232 \quad N_s = 2200$

$V/\bar{Q}_d = 20\%$:

$a/\bar{Q}_d = 0.232$

- ● n = 2 ┐
- ▼ n = 2.5 ├ TRI-SERVICE
- ▲ n = 3 │
- ■ n = 4 ┘

$V/\bar{Q}_d = 10\%$:

$a/\bar{Q}_d = 0.232$

- ○ n = 2 ┐
- ▽ n = 2.5 ├ TRI-SERVICE
- △ n = 3 │
- □ n = 4 ┘

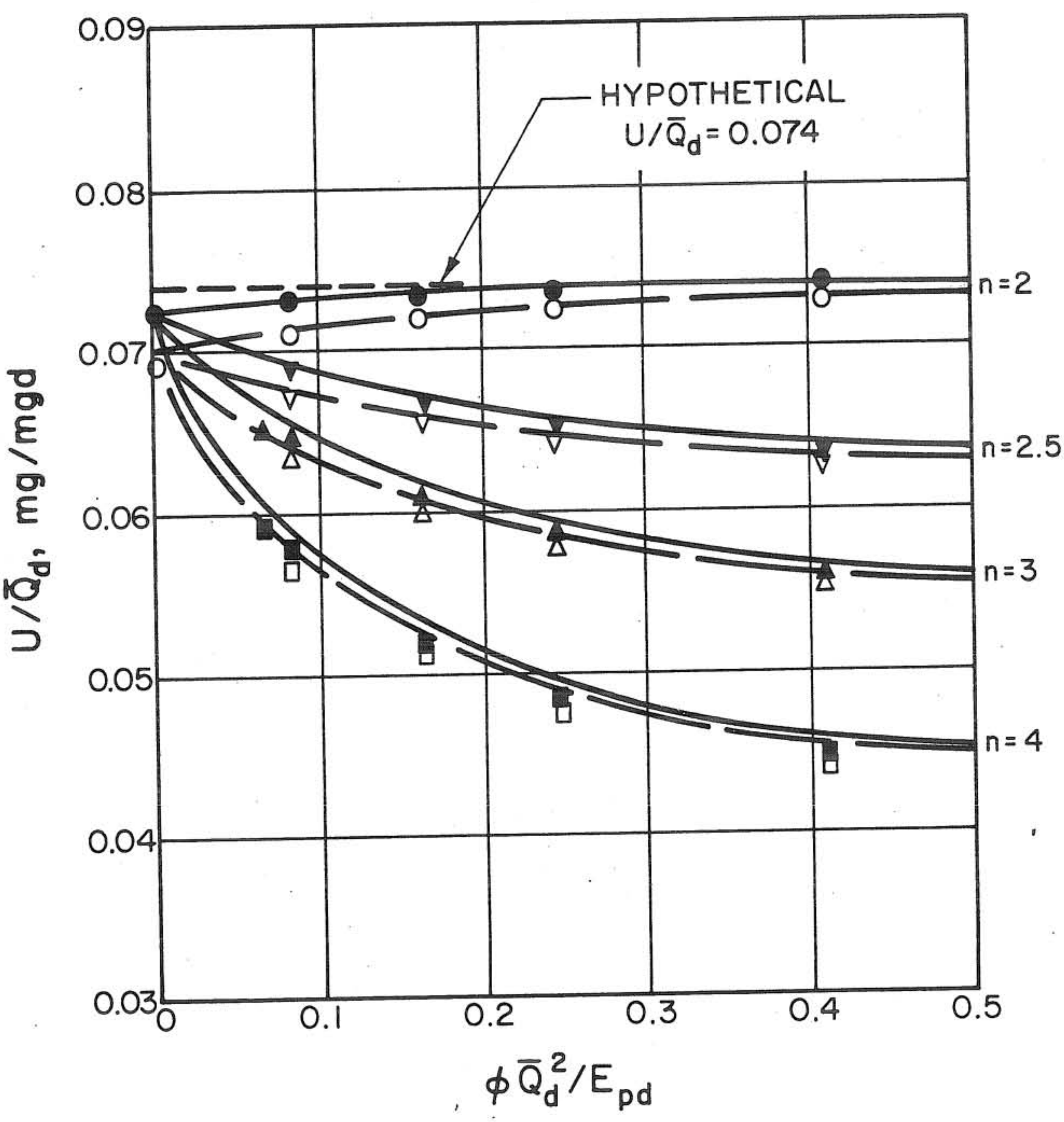


FIGURE TR-3

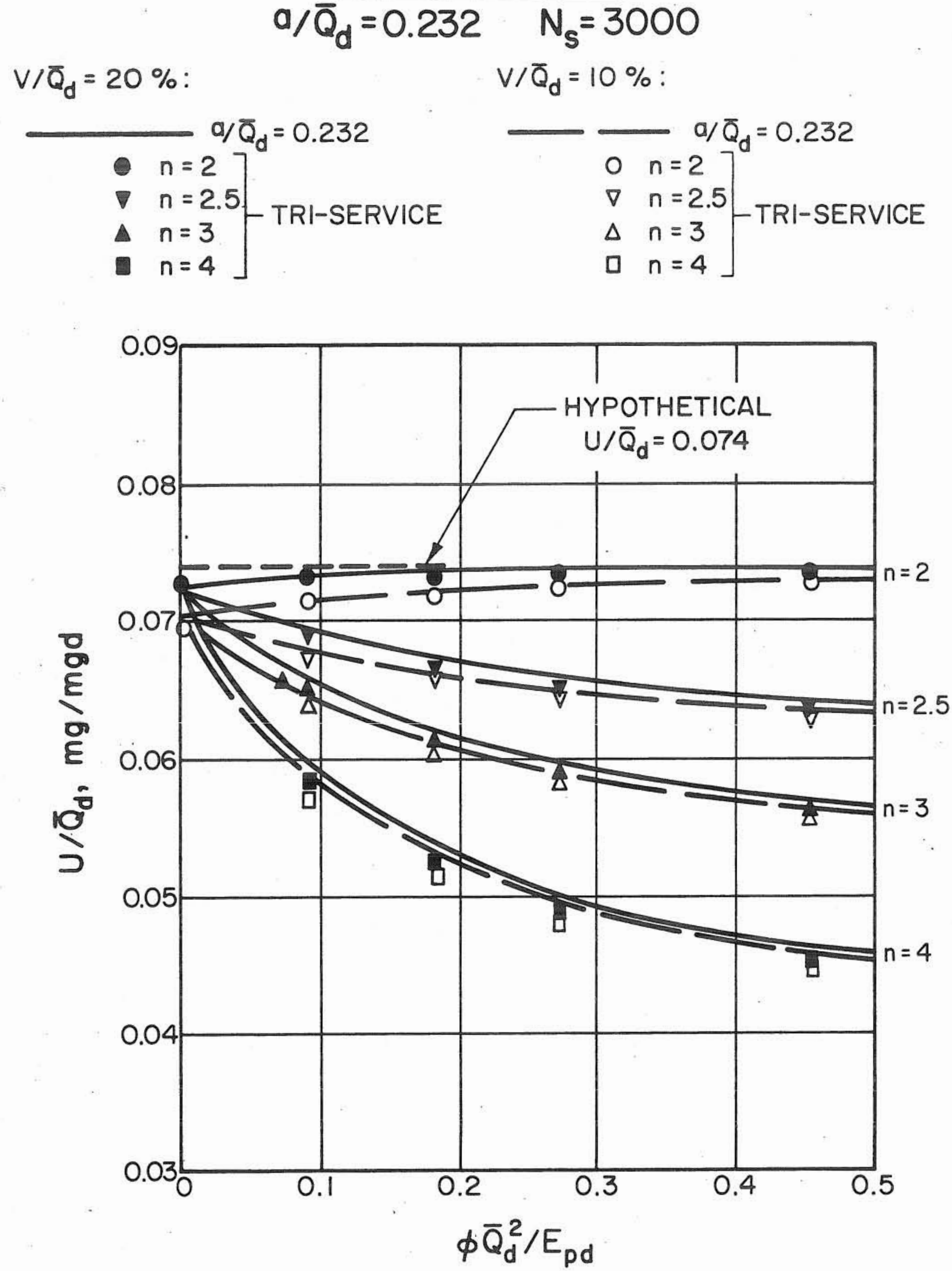

$a/\bar{Q}_d = 0.232 \quad N_s = 3000$
$V/\bar{Q}_d$ = 20 %:
$a/\bar{Q}_d$ = 0.232
n = 2
n = 2.5
n = 3
n = 4
TRI-SERVICE
$V/\bar{Q}_d$ = 10 %:
$a/\bar{Q}_d$ = 0.232
n = 2
n = 2.5
n = 3
n = 4
TRI-SERVICE
HYPOTHETICAL
$U/\bar{Q}_d$ = 0.074
$U/\bar{Q}_d$, mg/mgd
$\phi \bar{Q}_d^2 / E_{pd}$
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0
0.1
0.2
0.3
0.4
0.5
n = 2
n = 2.5
n = 3
n = 4

FIGURE TR-4

$a/\bar{Q}_d = 0.232 \quad N_s = 4000$

$V/\bar{Q}_d$ = 20 %:
———— $a/\bar{Q}_d$ = 0.232
● n = 2
▼ n = 2.5
▲ n = 3
■ n = 4
— TRI-SERVICE

$V/\bar{Q}_d$ = 10 %:
— — — $a/\bar{Q}_d$ = 0.232
○ n = 2
▽ n = 2.5
△ n = 3
□ n = 4
— TRI-SERVICE

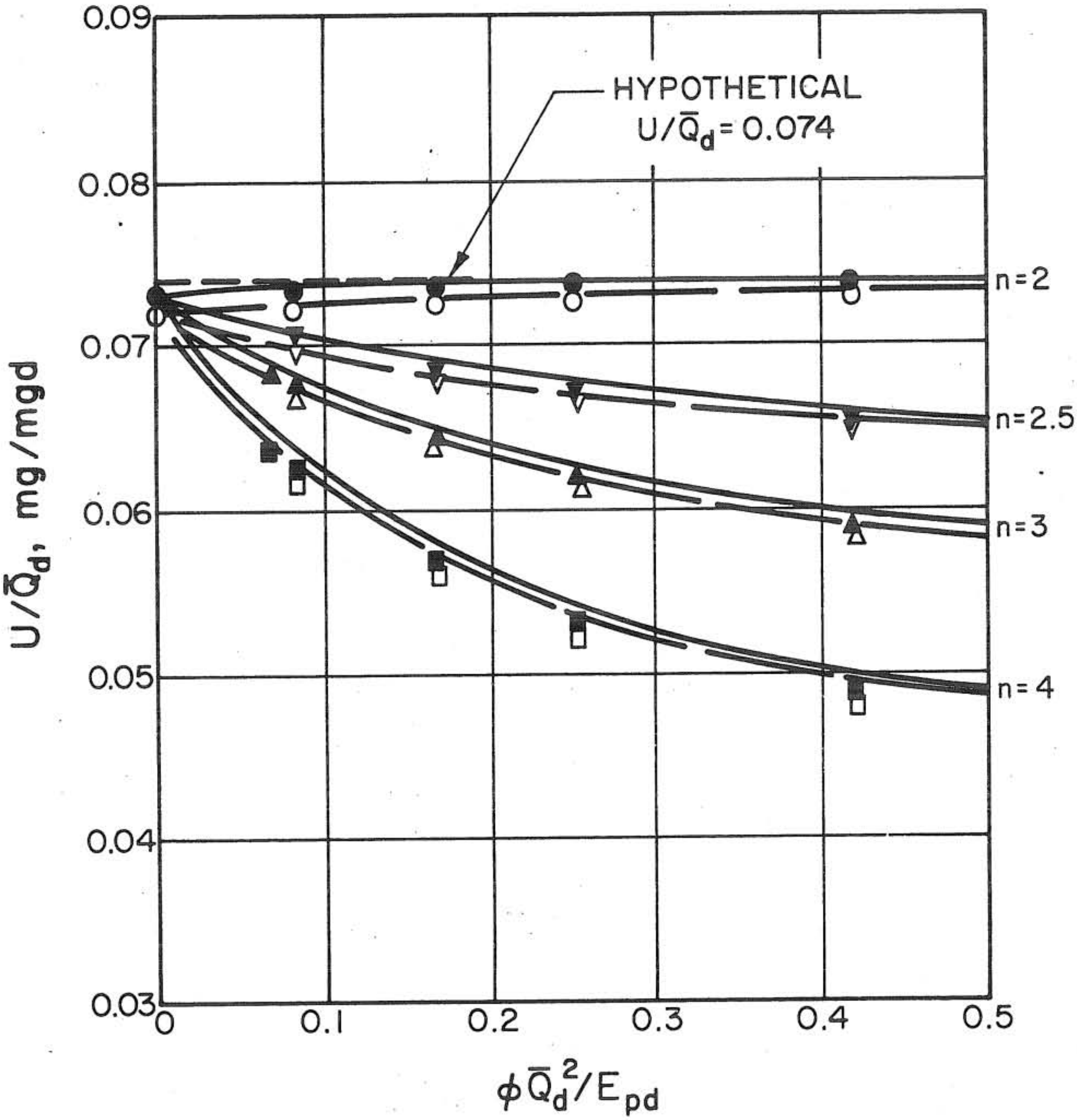


FIGURE B-2

$a/\bar{Q}_d = 0.353 \quad N_s = 2200$

$V/\bar{Q}_d$ = 20 %:

——— $a/\bar{Q}_d = 0.353$

● n = 2, ▼ n = 2.5, ▲ n = 3, ■ n = 4 — BELMONT H. S.

$V/\bar{Q}_d$ = 10 %:

— — — $a/\bar{Q}_d = 0.353$

○ n = 2, ▽ n = 2.5, △ n = 3, □ n = 4 — BELMONT H. S.

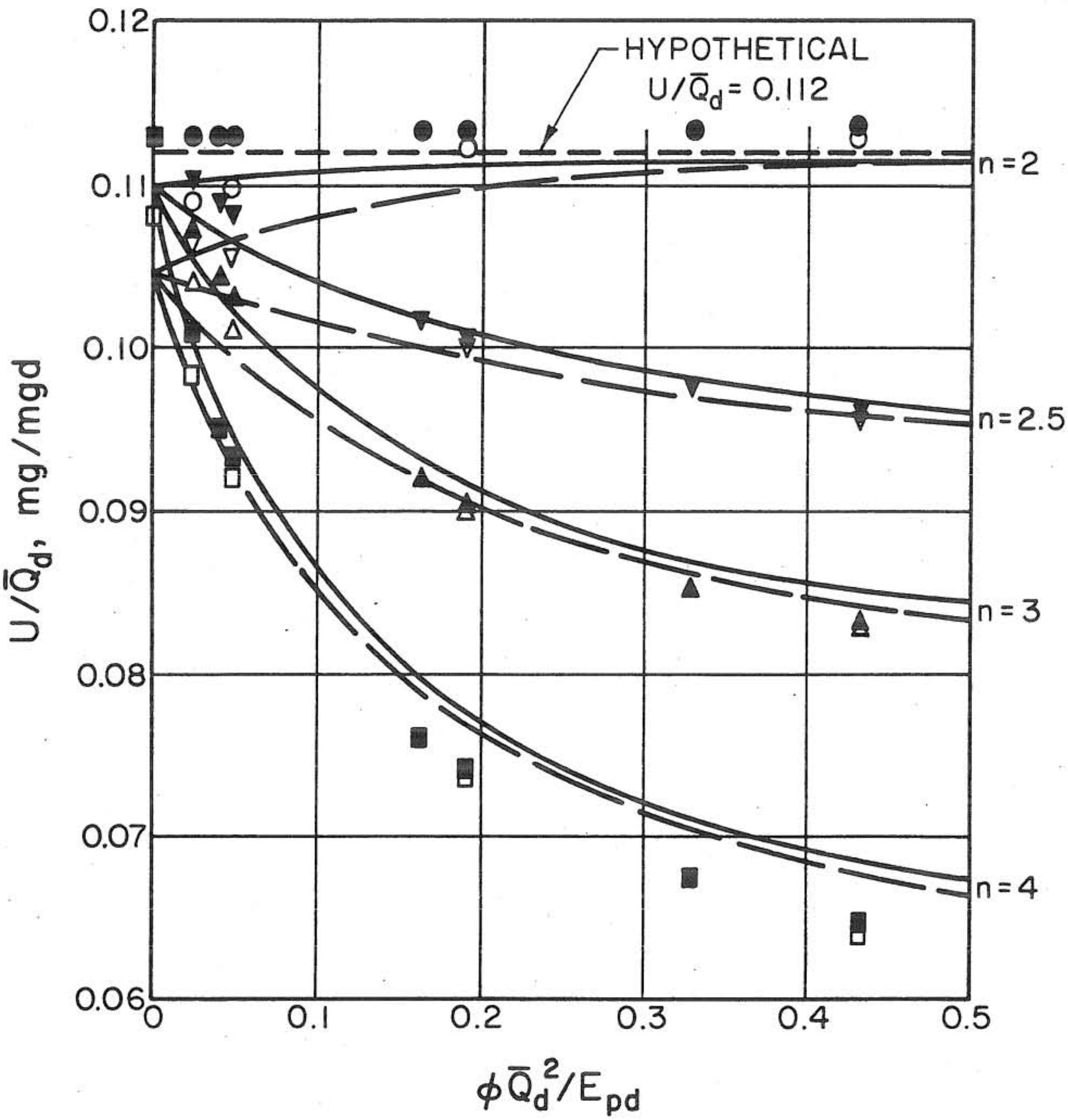
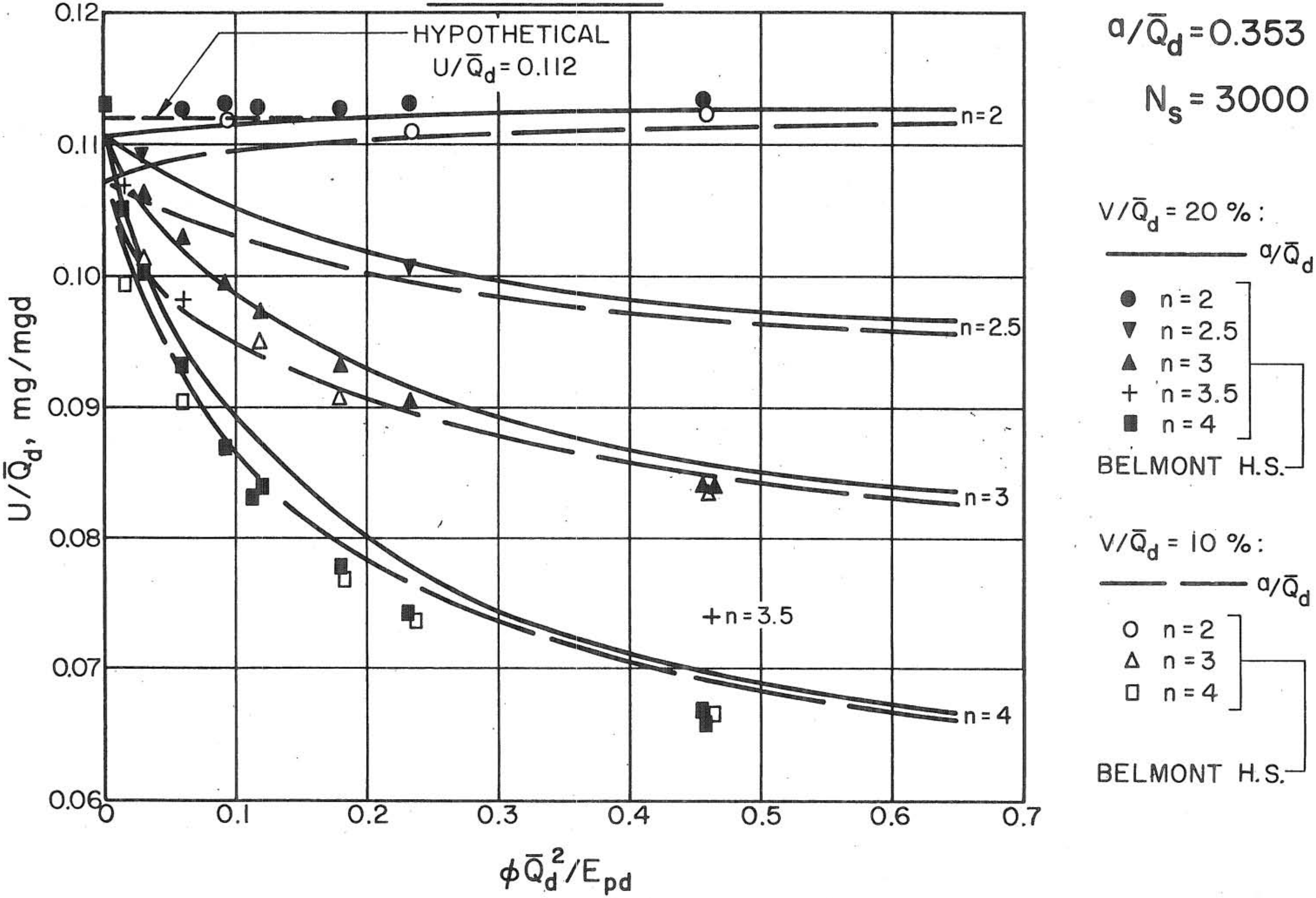
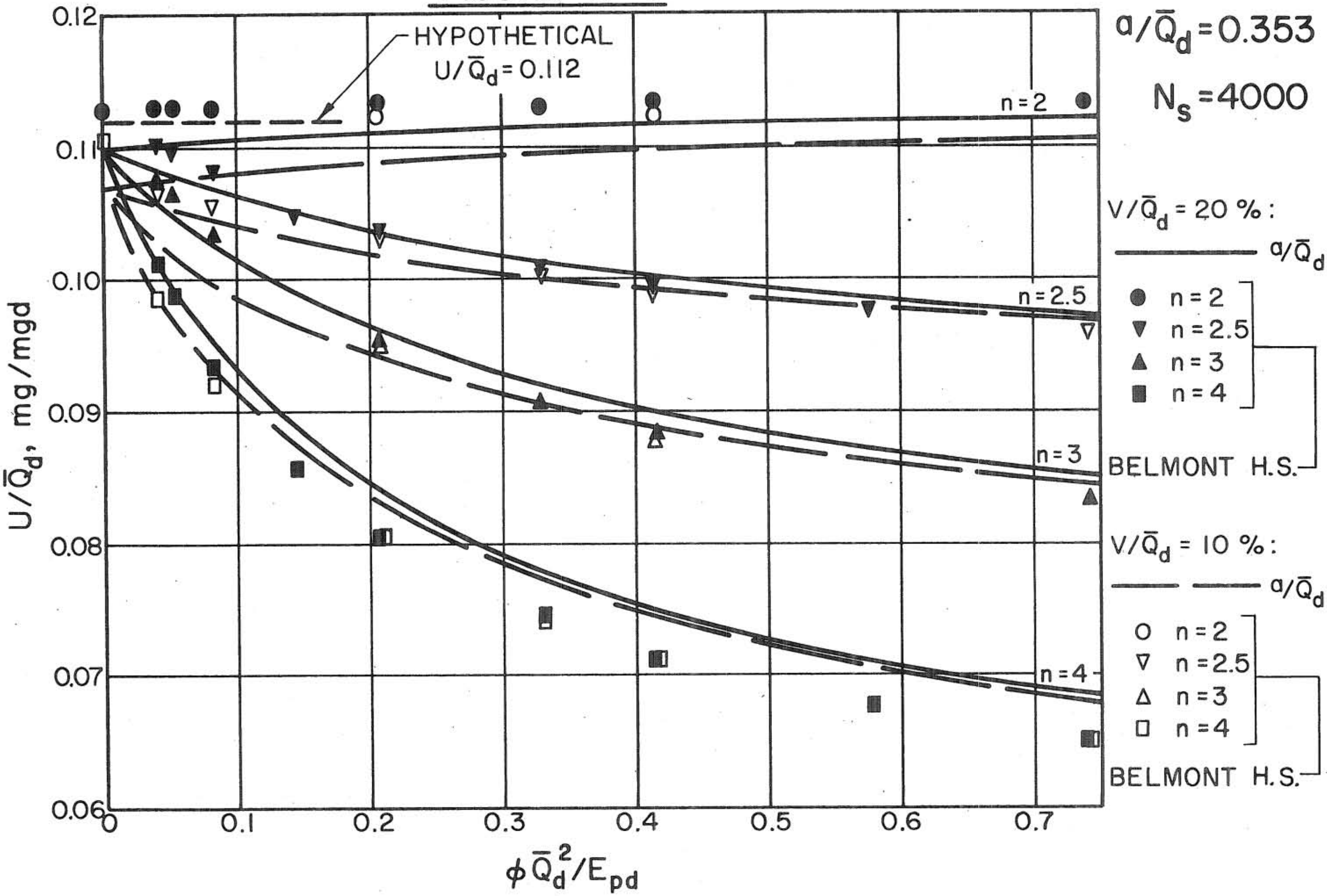


FIGURE B-3



HYPOTHETICAL
$U/\bar{Q}_d = 0.112$
$a/\bar{Q}_d = 0.353$
$N_s = 3000$
$V/\bar{Q}_d = 20\%$:
$a/\bar{Q}_d$
n = 2
n = 2.5
n = 3
n = 3.5
n = 4
BELMONT H.S.
$V/\bar{Q}_d = 10\%$:
$a/\bar{Q}_d$
n = 2
n = 3
n = 4
BELMONT H.S.
n=2
n=2.5
n=3
+n=3.5
n=4
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
$U/\bar{Q}_d$, mg/mgd
$\phi \bar{Q}_d^2/E_{pd}$

FIGURE B-4



HYPOTHETICAL
U/Q̄d = 0.112
n = 2
n = 2.5
n = 3
n = 4
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
U/Q̄d, mg/mgd
φQ̄d²/Epd
a/Q̄d = 0.353
Ns = 4000
V/Q̄d = 20 %:
a/Q̄d
n = 2
n = 2.5
n = 3
n = 4
BELMONT H.S.
V/Q̄d = 10 %:
a/Q̄d
n = 2
n = 2.5
n = 3
n = 4
BELMONT H.S.

FIGURE CU-2

$a/\bar{Q}_d = 0.468 \quad N_s = 2200$

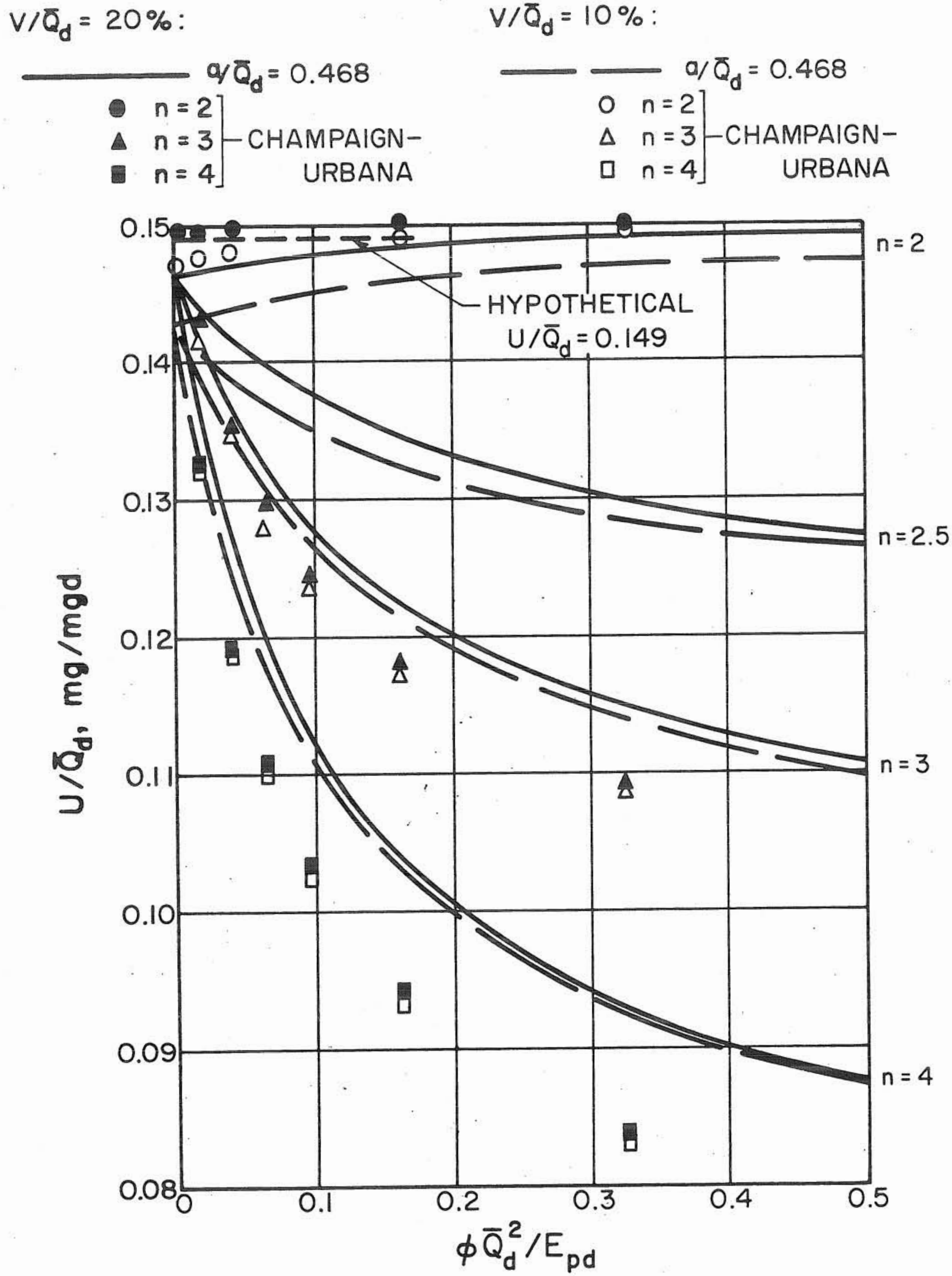


FIGURE CU-3

$a/\bar{Q}_d = 0.468 \quad N_s = 3000$

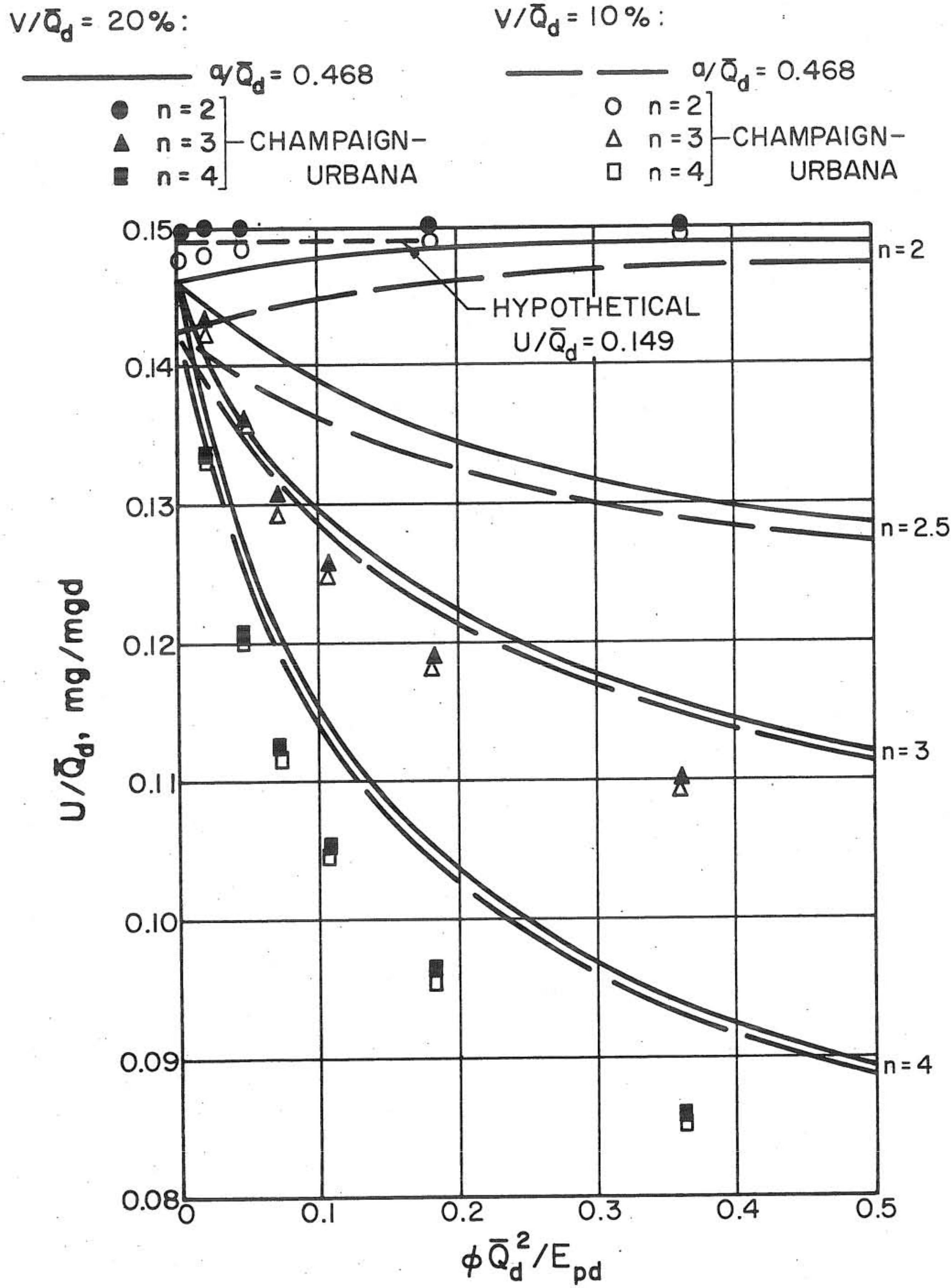


FIGURE CU-4

$a/\bar{Q}_d = 0.468 \quad N_s = 4000$

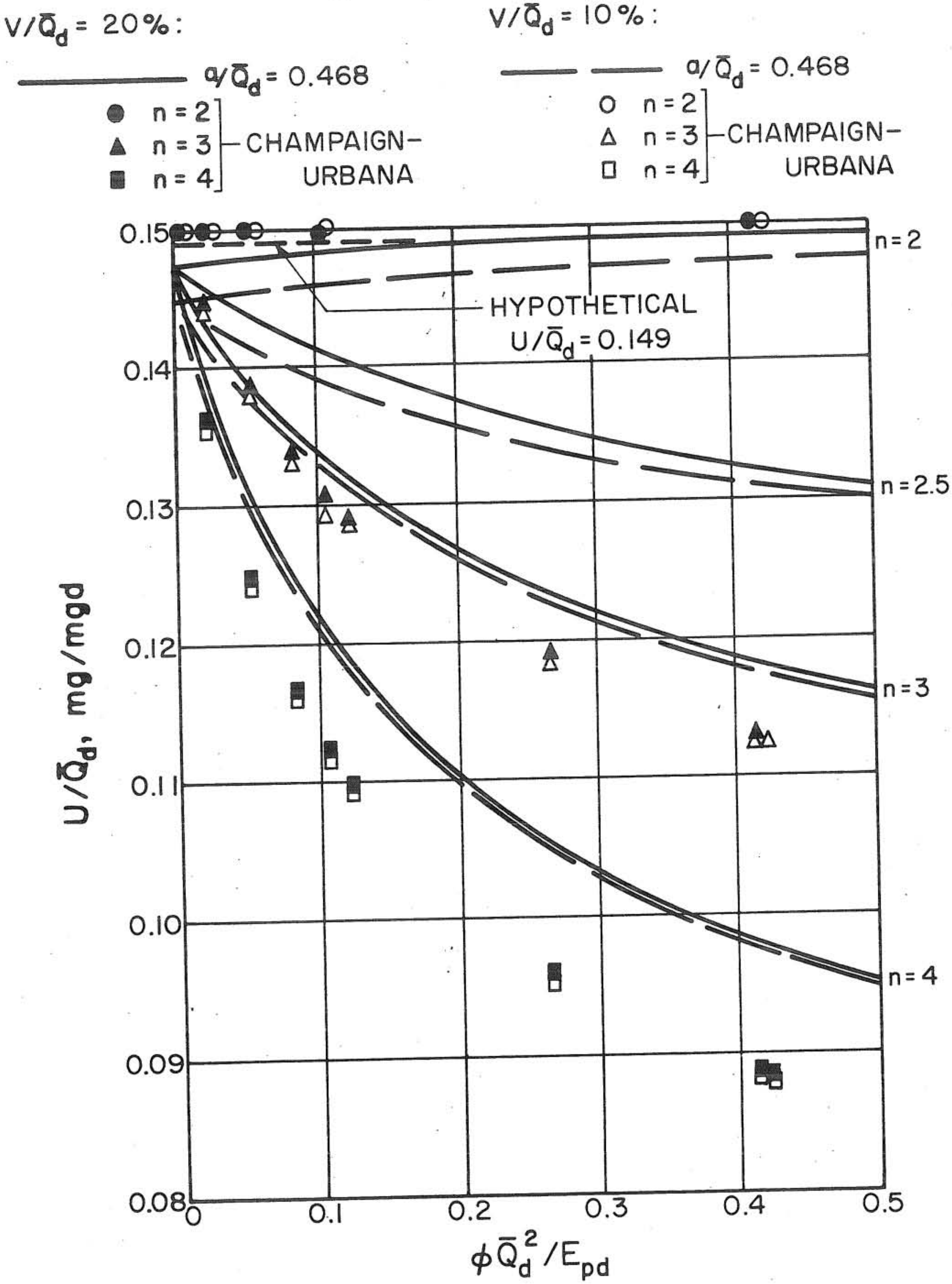


FIGURE NH-2

$a/\bar{Q}_d = 0.642 \quad N_s = 2200$

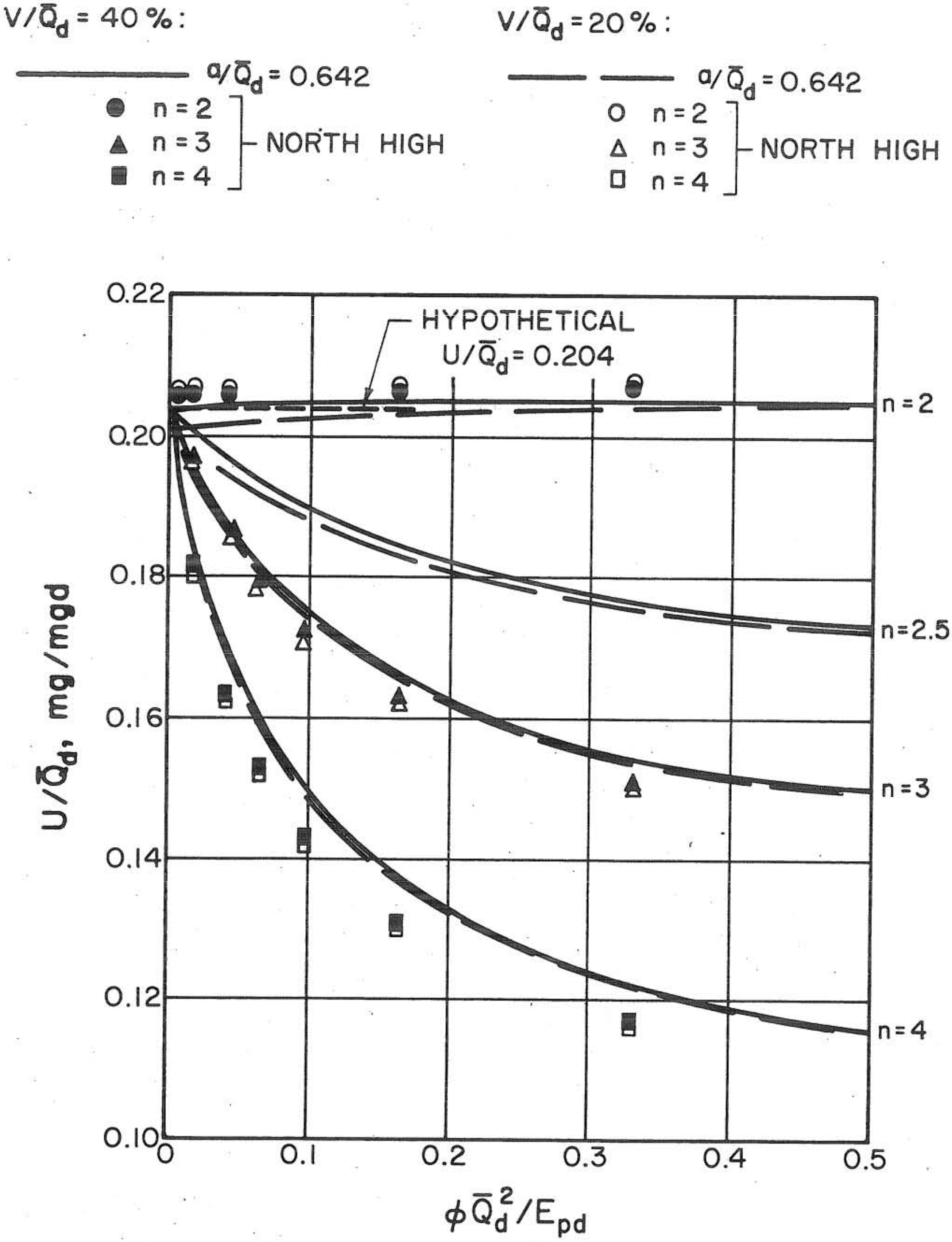


FIGURE NH-3

$a/\bar{Q}_d = 0.642 \quad N_s = 3000$

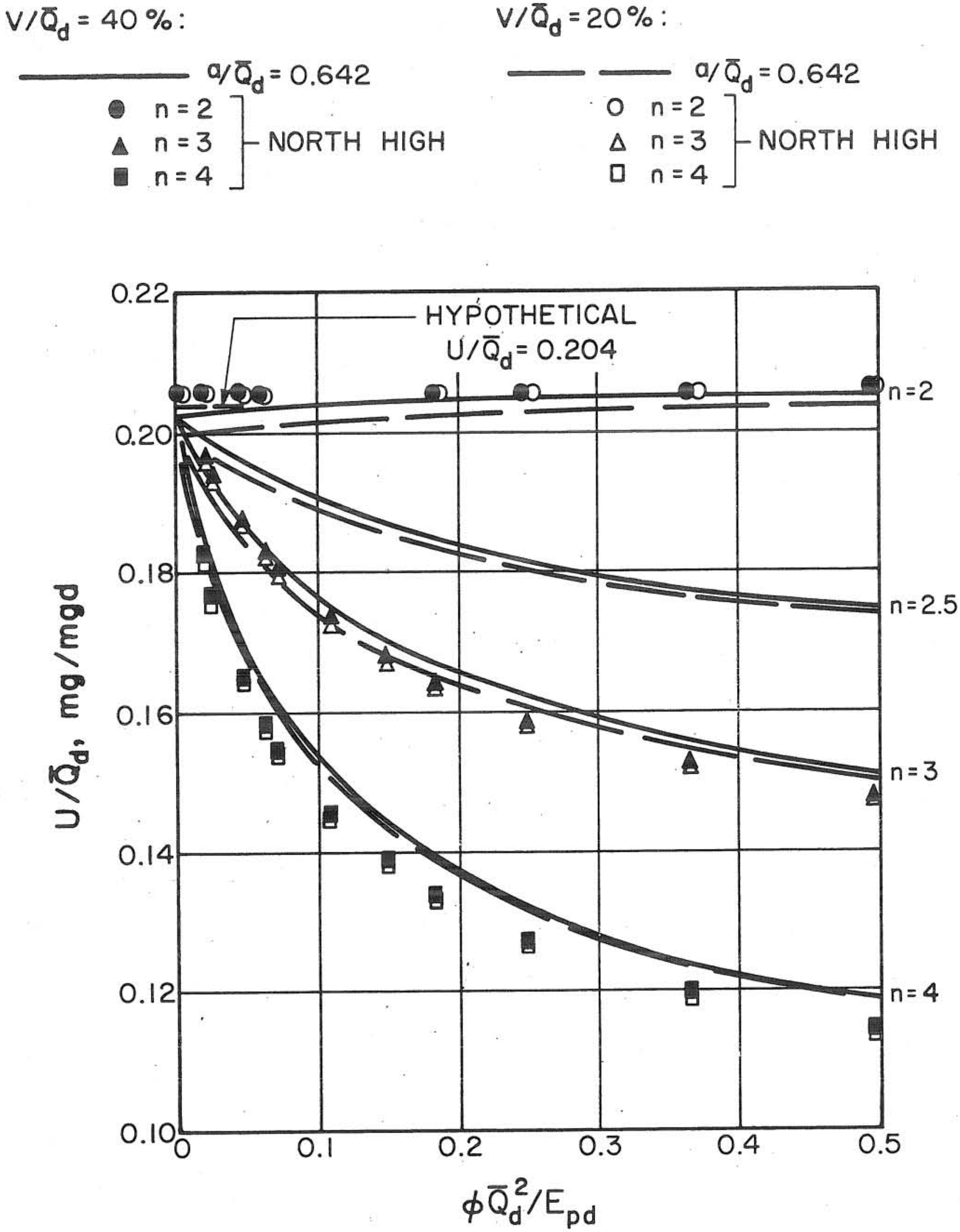


FIGURE NH-4

$a/\bar{Q}_d = 0.642 \quad N_s = 4000$

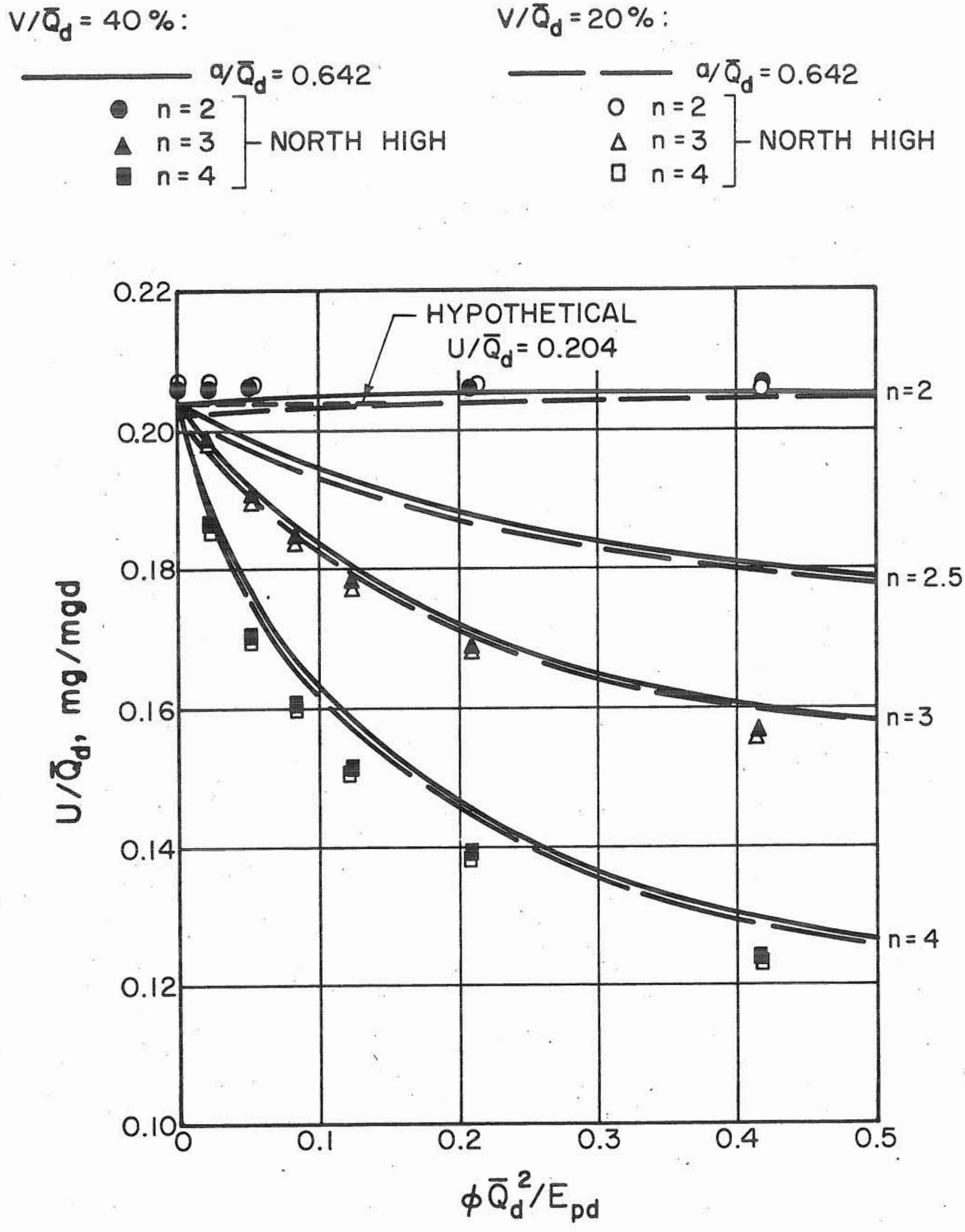


FIGURE TO-2

$a/\bar{Q}_d = 0.642 \quad N_s = 2200$

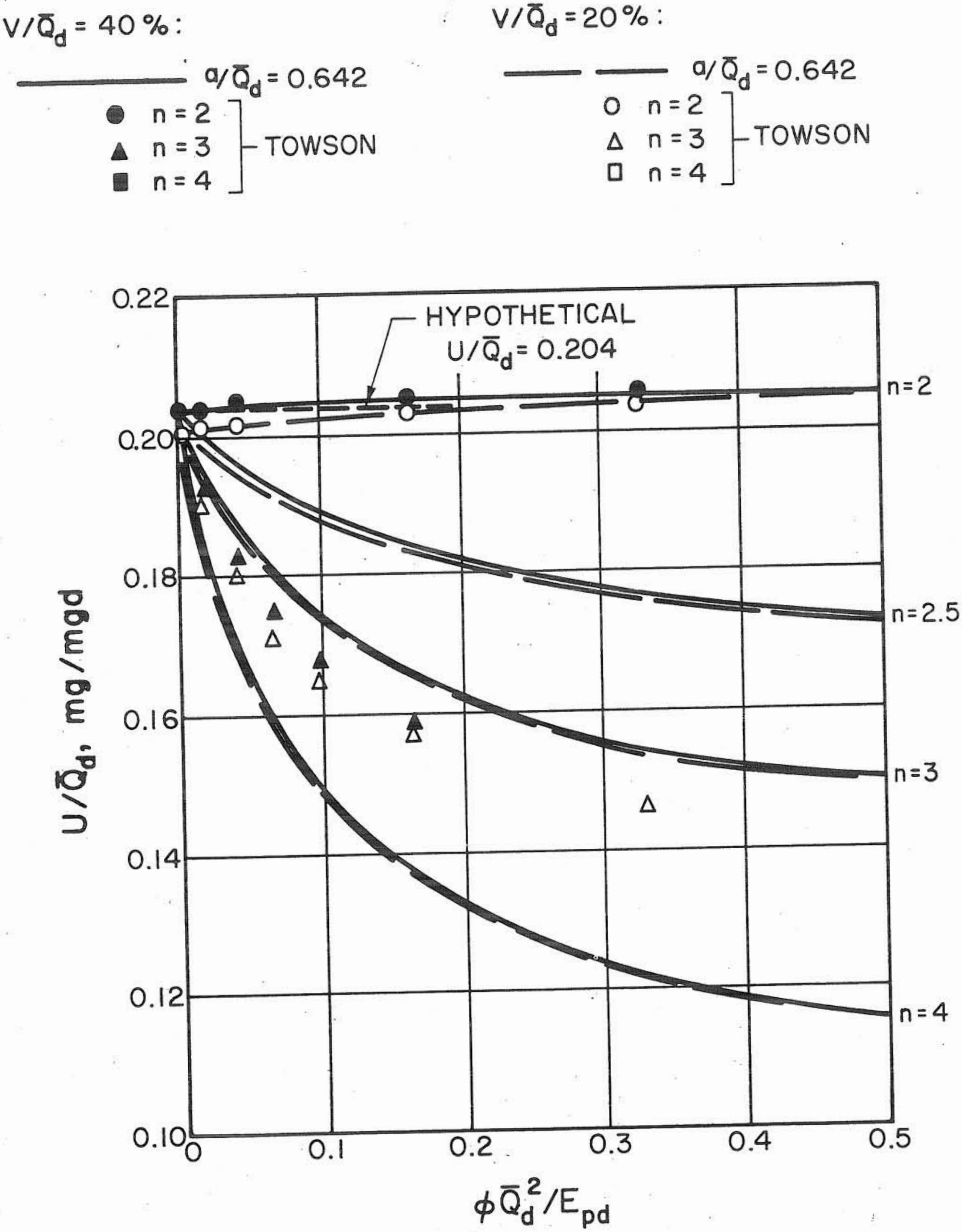


FIGURE TO-3

$a/\bar{Q}_d = 0.642 \quad N_s = 3000$

$V/\bar{Q}_d = 40\%$:

——— $a/\bar{Q}_d = 0.642$

● n = 2 ⎤
▲ n = 3 ⎬ TOWSON
■ n = 4 ⎦

$V/\bar{Q}_d = 20\%$:

— — — $a/\bar{Q}_d = 0.642$

○ n = 2 ⎤
△ n = 3 ⎬ TOWSON
□ n = 4 ⎦

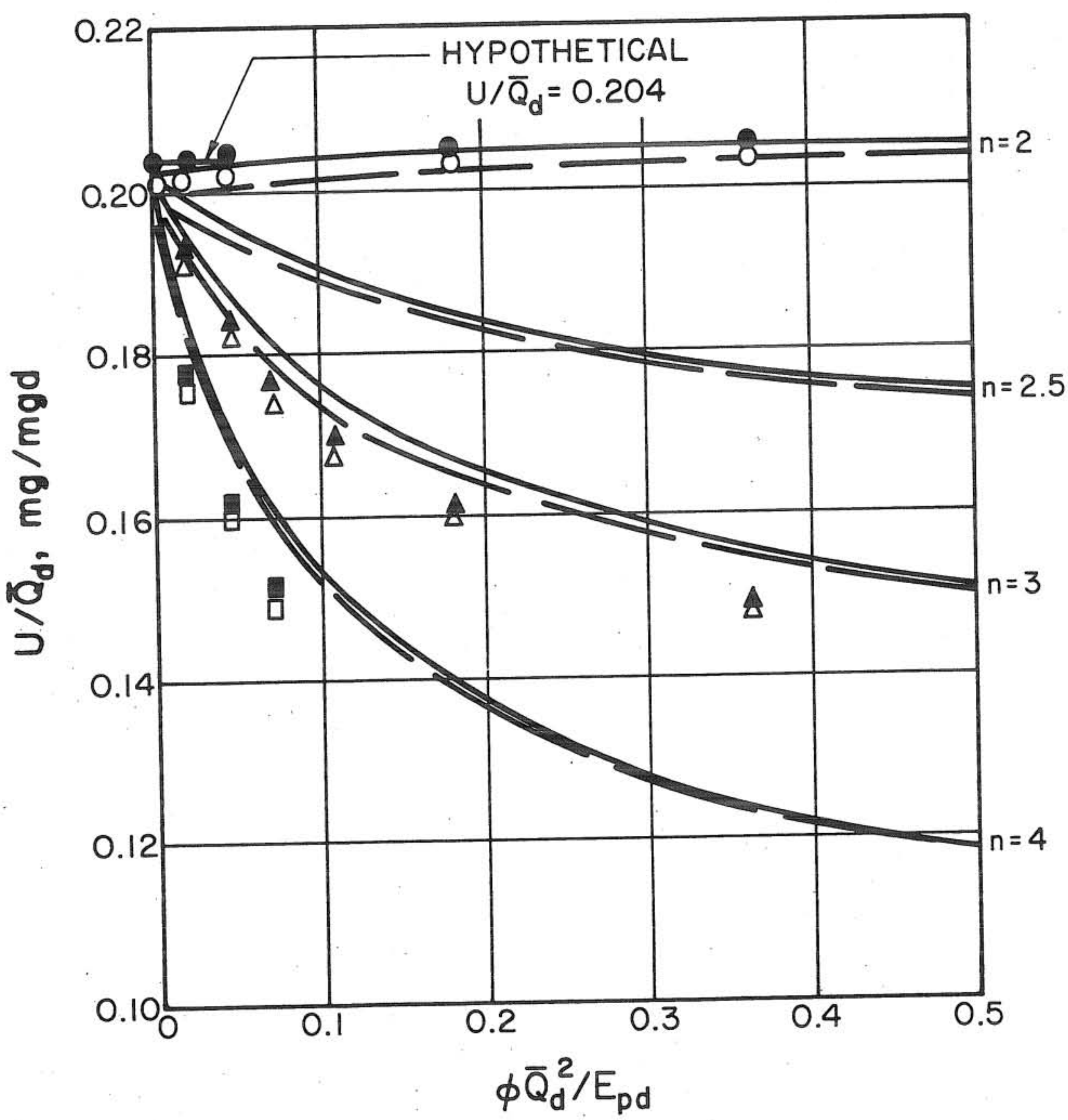


FIGURE TO-4

$a/\bar{Q}_d = 0.642 \quad N_s = 4000$

$V/\bar{Q}_d = 40\%$:

———— $a/\bar{Q}_d = 0.642$

● n = 2 ⎤
▲ n = 3 ⎬ TOWSON
■ n = 4 ⎦

$V/\bar{Q}_d = 20\%$:

— — — $a/\bar{Q}_d = 0.642$

○ n = 2 ⎤
△ n = 3 ⎬ TOWSON
□ n = 4 ⎦

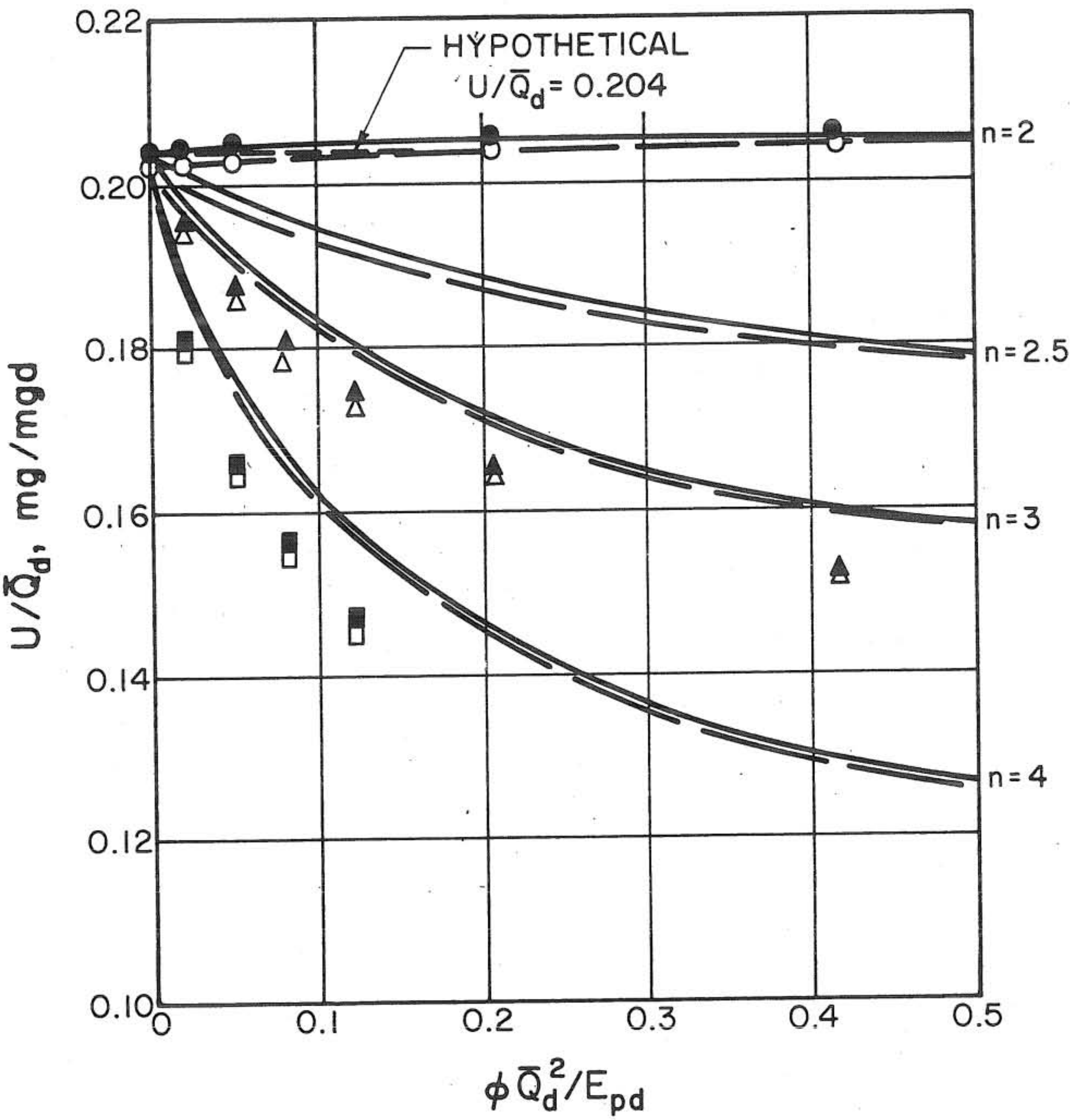


FIGURE RO-2

$a/\bar{Q}_d = 0.766 \quad N_s = 2200$

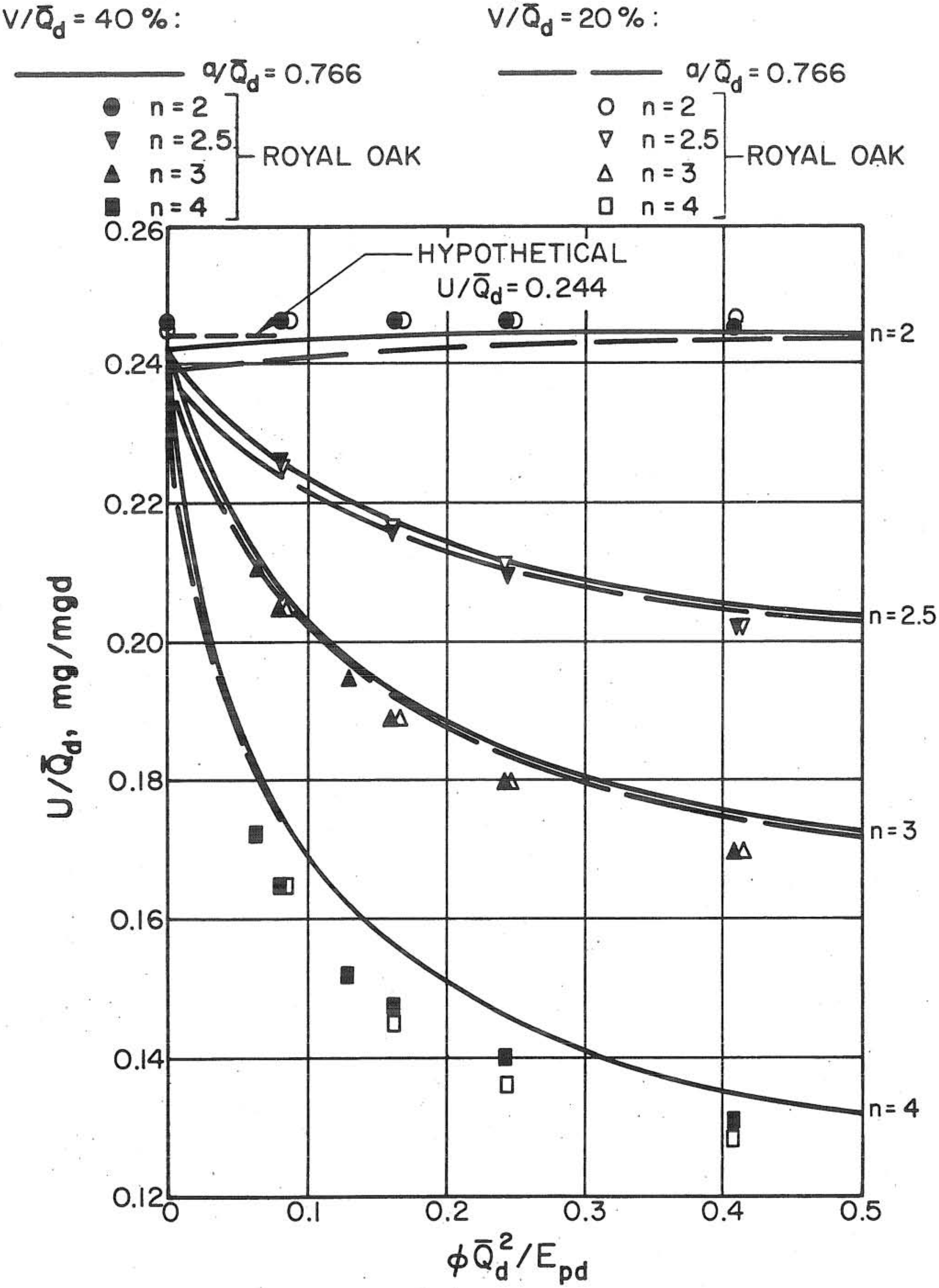


FIGURE RO-3

$a/\bar{Q}_d = 0.766 \quad N_s = 3000$

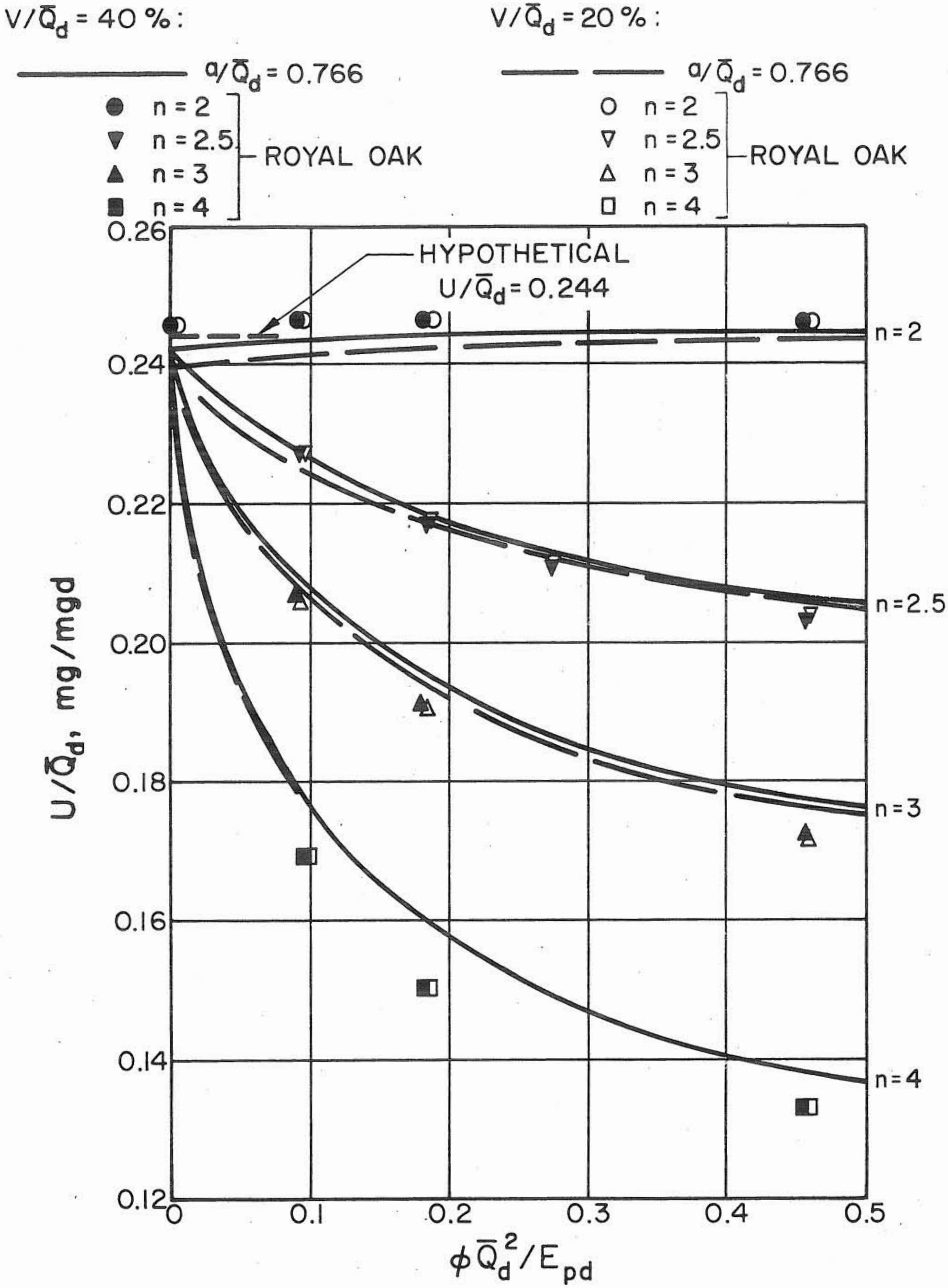


FIGURE RO-4

$a/\bar{Q}_d = 0.766 \quad N_s = 4000$

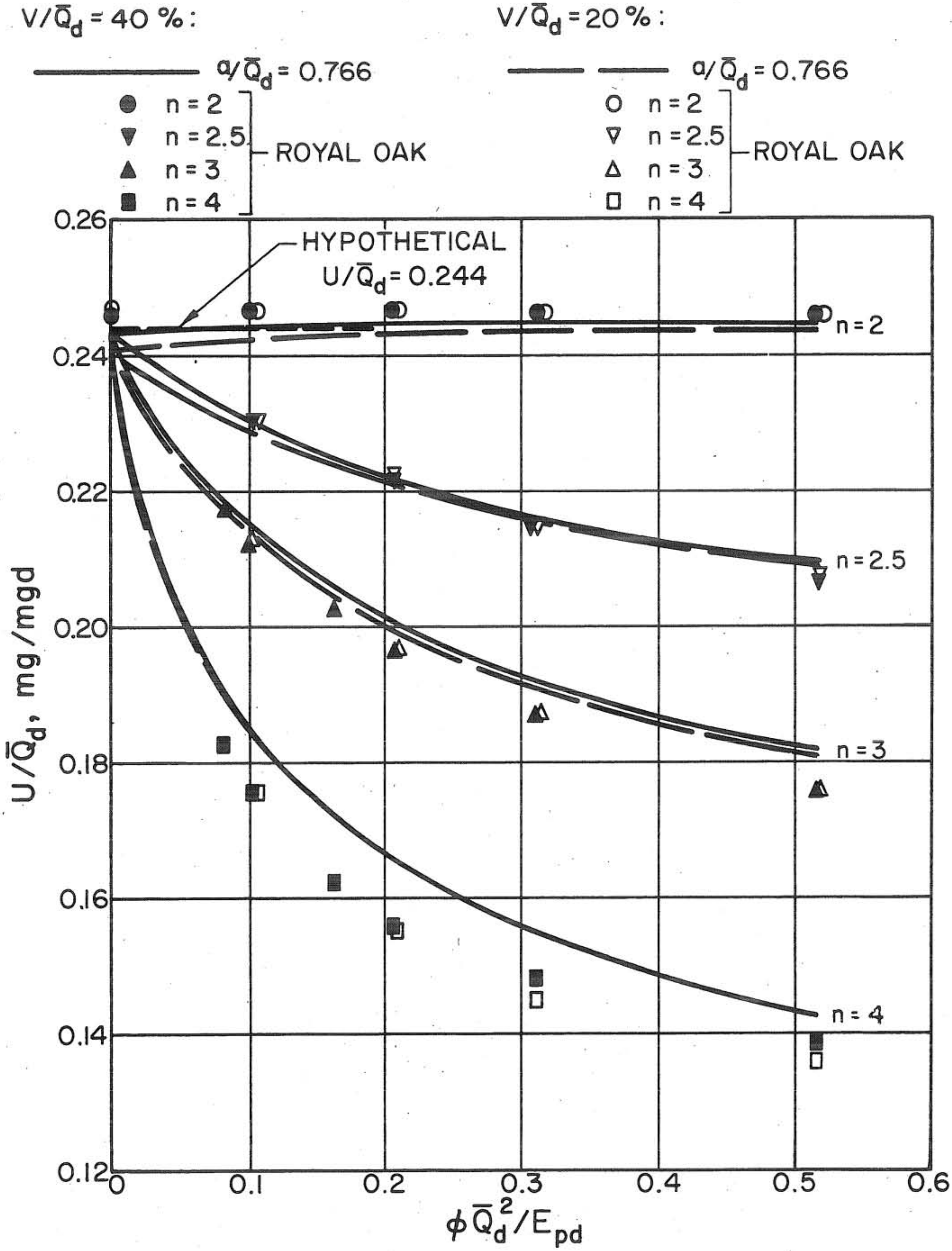


FIGURE LA-2

$a/\bar{Q}_d = 0.854 \quad N_s = 2200$

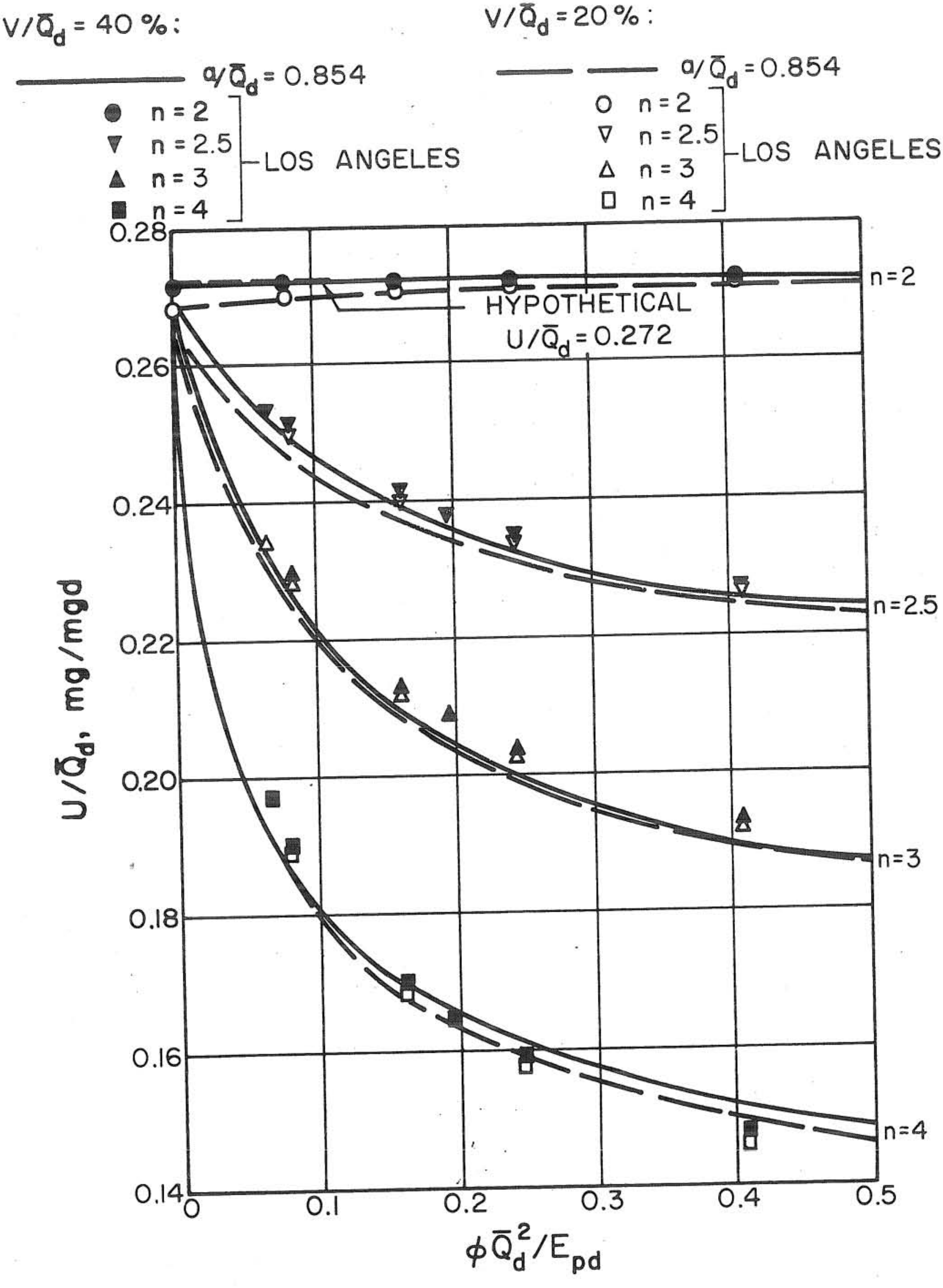


FIGURE LA-3

$a/\bar{Q}_d = 0.854 \quad N_s = 3000$

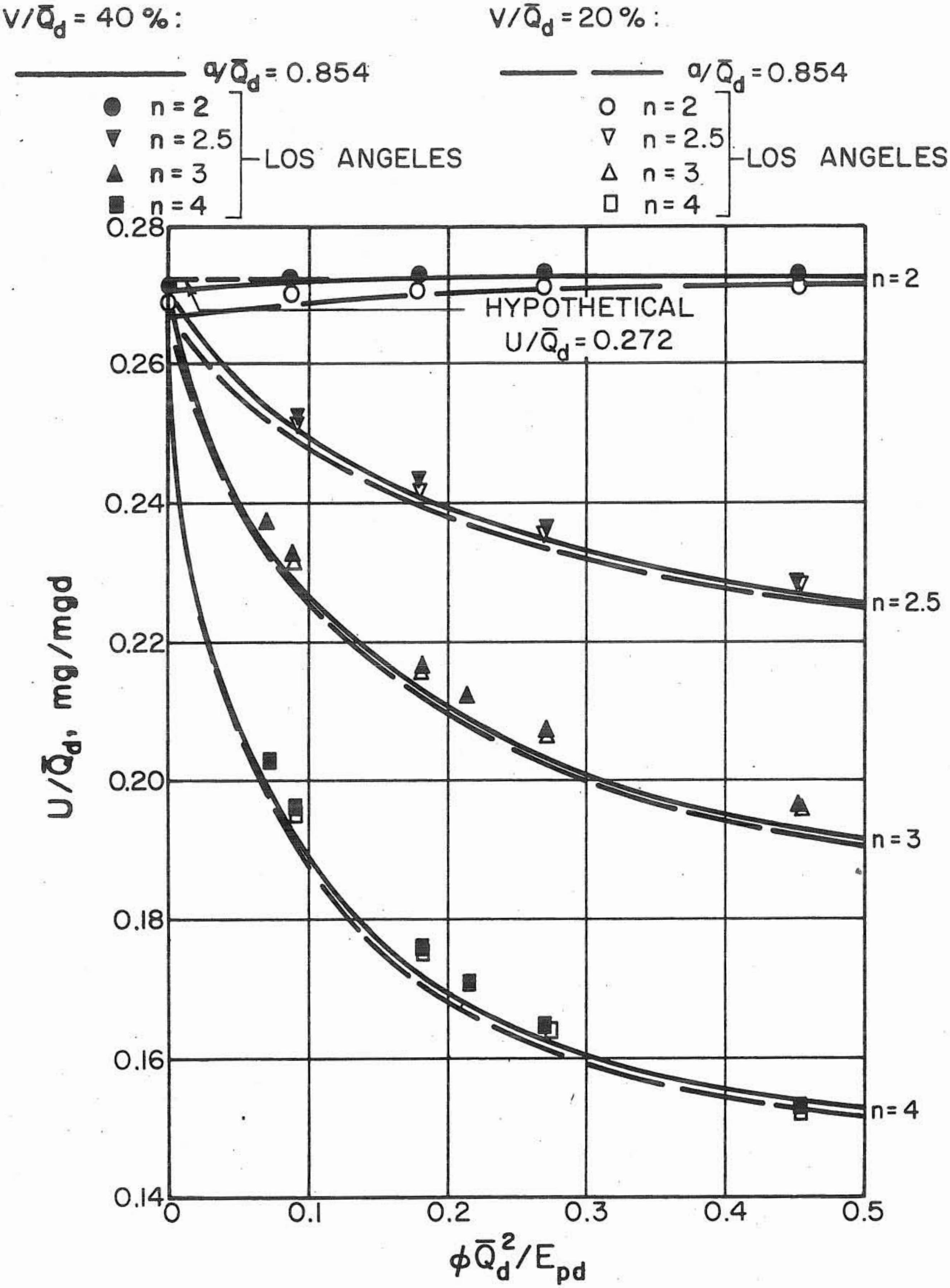
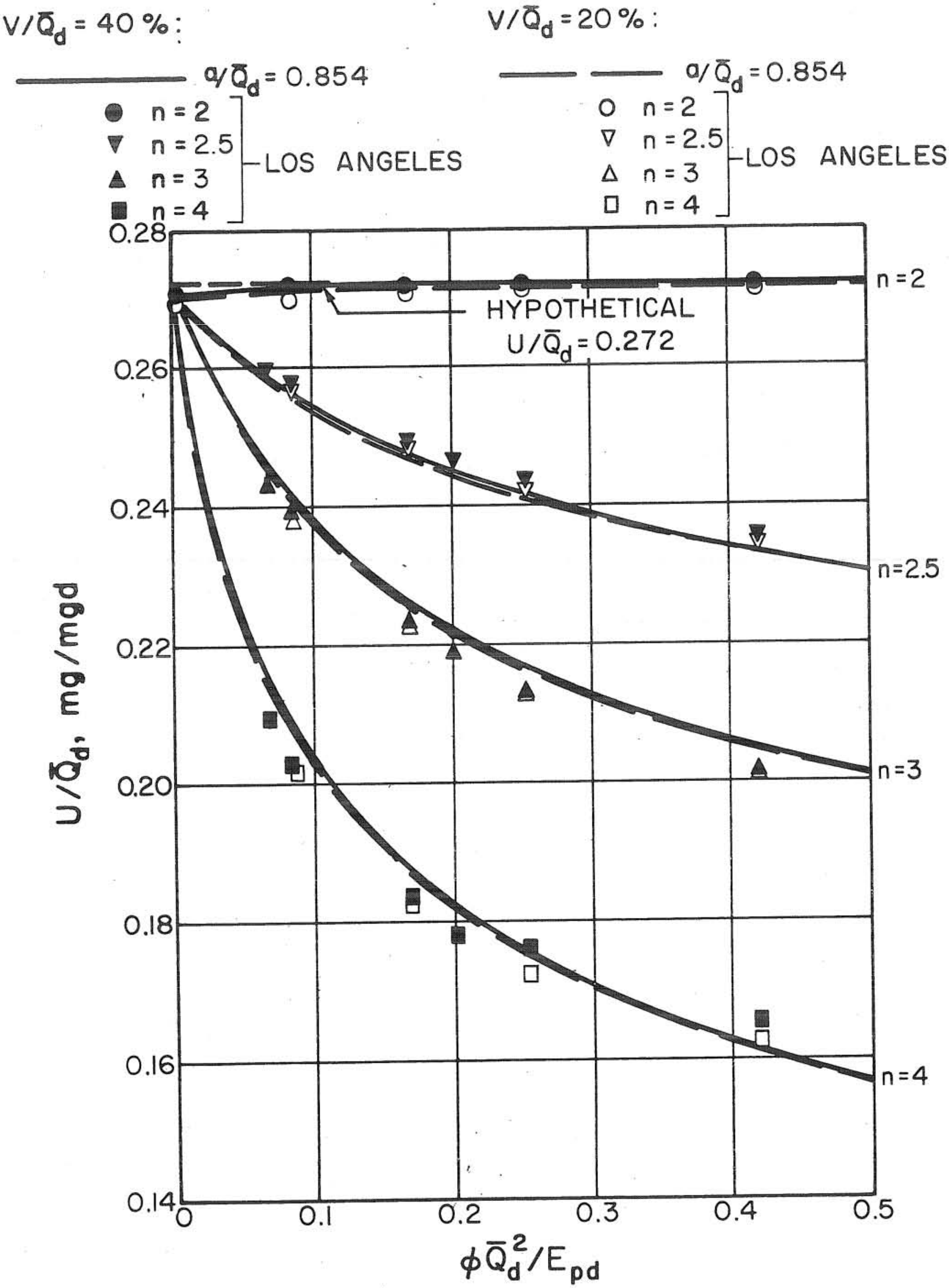


FIGURE LA-4

$a/\bar{Q}_d = 0.854 \quad N_s = 4000$



APPENDIX III

TABLES OF ALL COMPUTER RUN RESULTS, CONSTANT SUCTION

APPENDIX III

LIST OF TABLES

District	Table	N_s	$\overline{Q}_d$	E_{pd}	Notes
Tri-Service (20% & 10%)	TRIS-1	2200	20	243.3	
			10	153.3	
	TRIS-2	3000	20	219.1	
			10	138.1	
	TRIS-3	4000	20	236.9	
			10	149.3	
	TRIA-1	2200	20	243.3	
			10	153.3	
	TRIA-2	3000	20	219.1	
			10	138.1	
	TRIA-3	4000	20	236.9	
			10	149.3	
Belmont (20% & 10%)	BS-1	2200	10	208.8	
			20	243.3	
	BS-2	3000	20	219.1	
			10	138.0	
	BS-3	4000	10	120.9	
			20	191.9	
	BS-4	3000	20	219.1	$a/\overline{Q}_d = 0.394$
	BS-5	2200	20	243.3	n = 2.5, only
		3000	20	219.1	" "
		4000	20	191.9	" "
	BA-1	3000	10	138.1	20% & 17.5%
	BA-2	3000	10	138.1	15%, 12.5%, 10%, 7.5%
	BA-3	3000	10	70.4	20%, 17.5%, 15%, 12.5%
	BA-4	3000	20	219.1	20%, 10%
			20	118.1	20%, 10%
	BA-5	4000	10	120.9	20%, 10%
			10	69.1	20% (4 runs)
			10	94.0	20% (1 run)
	BA-6	4000	20	191.9	20%, 10%
			20	149.3	10% (2 runs)
	BA-7	2200	10	208.8	20%, 10%
	BA-8	2200	20	243.3	20%

(Continued)

APPENDIX III

LIST OF TABLES (CONTINUED)

District	Table	N_s	$\overline{Q}_d$	E_{pd}	Notes
Champaign-Urbana (20% & 10%)	CUS-1 (a)	2200	10	268.2	
			20	425.8	
	CUS-1 (b)	2200	20	243.3	
			10	153.3	
	CUS-2 (a)	3000	20	219.1	
			10	138.0	
	CUS-2 (b)	3000	10	138.0	
			20	160.9	
	CUS-3 (a)	4000	20	191.9	
			10	120.9	
	CUS-3 (b)	4000	10	94.1	
			20	149.3	
	CUS-4	2200	20	243.3	n = 2, only
		3000	20	219.1	" "
		4000	20	191.1	" "
	CUA-1	2200	20	243.3	
			10	153.3	
	CUA-2 (a)	3000	20	219.1	
			10	138.0	
	CUA-2 (b)	3000	10	138.0	
			20	160.9	
	CUA-3 (a)	4000	20	191.9	
			10	120.9	
	CUA-3 (b)	4000	10	94.1	
			20	149.3	
North High, Towson (40% & 20%)	TNHS-1	2200	20	243.3	
			10	153.3	
	TNHS-2	3000	20	160.9	
			10	101.3	
	TNHS-3	4000	20	191.9	
			10	120.9	
	TNHS-4	2200	20	191.9	n = 25, only
		3000	20	219.1	" "
		4000	20	243.3	" "
	NHA-1	2200	20	243.3	
			10	153.3	
	NHA-2 (a)	3000	20	219.1	
			10	138.0	
	NHA-2 (b)	3000	20	160.9	
			10	101.3	
	NHA-3	4000	20	191.9	
			10	120.9	
	TOA-1	2200	20	243.3	no n = 4
			10	153.3	" " "
	TOA-2	3000	20	219.1	Few n = 4
			10	138.0	" " "
	TOA-3	4000	20	191.9	Half of n = 4
			10	120.9	All n = 4

(Continued)

APPENDIX III

LIST OF TABLES (CONTINUED)

Tables of $Q_p/\overline{Q}_d$, Addenda to Preceeding Data

TABLE TRIS-1

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.232$

Specific Speed : $N_s = 2,200$ $N = 1150$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{Y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 Ft.)						
4	2	0	247.7	-4.5	0	0	.0725	0.2	.3124	
(20%)		0.05	227.9	15.4	20	0.082	.0732	20.0	.3154	
		0.10	208.0	35.3	40	0.164	.0736	39.9	.3173	
($\hat{Y}$ =		0.15	188.0	55.3	60	0.247	.0737	59.9	.3177	
4.6')		0.25	148.1	95.2	100	0.411	.0739	99.8	.3187	
	2.5	0.05	227.5	15.8	20	0.082	.0692	20.4	.2983	
		0.10	207.3	36.0	40	0.164	.0672	40.6	.2898	
		0.15	187.1	56.2	60	0.247	.0659	60.8	.2839	
		0.25	146.8	96.5	100	0.411	.0642	101.1	.2765	
	3	0.05	227.0	16.3	20	0.082	.0655	20.9	.2821	
		0.10	206.6	36.7	40	0.164	.0618	41.3	.2665	
		0.15	186.2	57.1	60	0.247	.0594	61.7	.2561	
		0.25	145.7	97.6	100	0.411	.0567	102.2	.2443	
	4	0.05	226.0	17.3	20	0.082	.0591	21.9	.2545	
		0.10	205.2	38.1	40	0.164	.0530	42.7	.2286	
		0.15	184.6	58.7	60	0.247	.0497	63.3	.2140	
		0.25	143.8	99.5	100	0.411	.0458	104.1	.1976	
2	2	0	251.9	-8.6	0	0	.0701	0.6	.3020	0.4'*
(10%)		0.05	232.1	11.2	20	0.082	.0715	20.4	.3083	0.2'*
		0.10	212.2	31.1	40	0.164	.0721	40.3	.3109	
($\hat{Y}$ =		0.15	192.2	51.0	60	0.247	.0724	60.3	.3122	
9.2')		0.25	152.4	90.8	100	0.411	.0730	100.1	.3146	
	2.5	0.05	231.5	11.8	20	0.082	.0677	21.0	.2917	0.2'*
		0.10	211.1	32.2	40	0.164	.0659	41.4	.2842	
		0.15	190.9	52.4	60	0.247	.0648	61.6	.2793	
		0.25	150.5	92.7	100	0.411	.0635	102.0	.2735	
	3	0.05	230.8	12.5	20	0.082	.0642	21.7	.2765	0.2'*
		0.10	210.1	33.2	40	0.164	.0608	42.4	.2619	
		0.15	189.6	53.6	60	0.247	.0586	62.9	.2524	
		0.25	149.0	94.3	100	0.411	.0561	103.5	.2420	
	4	0.05	229.4	13.9	20	0.082	.0580	23.1	.2500	
		0.10	208.3	35.0	40	0.164	.0524	44.2	.2261	
		0.15	187.5	55.8	60	0.247	.0491	65.0	.2117	
		0.25	146.5	96.8	100	0.411	.0455	106.0	.1962	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)						
2	3	0.10	147.1	6.2	10	0.065	.0657	10.8	.2833	
(20%)	4	0.10	146.5	6.8	10	0.065	.0605	11.4	.2607	
($\hat{Y}$ = 4.6')										
1	3	0.10	150.7	2.5	10	0.065	.0626	11.8	.2696	0.4'*
(10%)	4	0.10	149.8	3.4	10	0.065	.0579	12.6	.2495	0.3'*
($\hat{Y}$ = 9.2')										

(*: approximate runs).

TABLE TRIS-2

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.232$

Specific Speed : $N_s = 3{,}000$ $N = 1{,}450$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 Ft.)						
4	2	0	223.5	-4.4	0	0	.0725	0.2	.3125	
(20%)		0.05	203.7	15.4	20	0.091	.0733	20.0	.3160	
		0.10	183.8	35.3	40	0.183	.0736	39.9	.3172	
($\hat{y}$ =		0.15	163.9	55.3	60	0.274	.0738	59.9	.3181	
4.6')		0.25	124.0	95.2	100	0.456	.0740	99.8	.3190	
	2.5	0.05	203.4	15.8	20	0.091	.0695	20.4	.2997	
		0.10	183.1	36.0	40	0.183	.0674	40.6	.2907	
		0.15	162.9	56.2	60	0.274	.0661	60.8	.2849	
		0.25	122.7	96.5	100	0.456	.0644	101.1	.2777	
	3	0.05	202.9	16.3	20	0.091	.0659	20.9	.2842	
		0.10	182.4	36.8	40	0.183	.0622	41.4	.2681	
		0.15	162.0	57.1	60	0.274	.0599	61.7	.2582	
		0.25	121.5	97.7	100	0.456	.0570	102.3	.2458	
	4	0.05	20.19	17.3	20	0.091	.0598	21.9	.2576	
		0.10	180.9	38.2	40	0.183	.0538	42.8	.2317	
		0.15	160.3	58.8	60	0.274	.0502	63.5	.2165	
		0.25	119.5	99.6	100	0.456	.0464	104.3	.2000	
2	2	0	227.7	-8.6	0	0	.0705	0.7	.3040	0.4'*
(10%)		0.05	207.9	11.2	20	0.091	.0717	20.4	.3090	0.2'*
		0.10	188.0	31.1	40	0.183	.0722	40.3	.3113	
($\hat{y}$ =		0.15	168.1	51.0	60	0.274	.0725	60.3	.3125	
9.2')		0.25	128.3	90.8	100	0.456	.0731	100.1	.3150	
	2.5	0.05	207.3	11.8	20	0.091	.0680	21.1	.2931	0.2'*
		0.10	186.9	32.2	40	0.183	.0662	41.4	.2854	
		0.15	166.7	52.4	60	0.274	.0651	61.6	.2806	
		0.25	126.4	92.7	100	0.456	.0637	102.0	.2747	
	3	0.05	206.6	12.5	20	0.091	.0646	21.8	.2785	
		0.10	186.0	33.2	40	0.183	.0613	42.4	.2641	
		0.15	165.5	53.7	60	0.274	.0590	62.9	.2545	
		0.25	124.7	94.4	100	0.456	.0565	103.6	.2434	
	4	0.05	205.2	13.9	20	0.091	.0587	23.1	.2531	
		0.10	184.0	35.1	40	0.183	.0531	44.3	.2290	
		0.15	163.2	55.9	60	0.274	.0497	65.2	.2142	
		0.25	122.0	97.1	100	0.456	.0460	106.3	.1982	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)						
2	3	0.10	131.9	6.1	10	0.072	.0662	10.8	.2854	
(20%)	4	0.10	131.3	6.8	10	0.072	.0611	11.4	.2636	
($\hat{y}$ = 4.6')										
1	3	0.10	135.5	2.5	10	0.072	.0633	11.8	.2728	0.4'*
(10%)	4	0.10	134.6	3.4	10	0.072	.0587	12.7	.2531	0.3'*
($\hat{y}$ = 9.2')										

(*: approximate runs).

TABLE TRIS-3

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d}$ = 0.232

Specific Speed : N_s = 4,000 N = 2,050 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
			($\overline{Q_d}$ = 20 mgd; E_{pd} = 236.9 Ft.)							
4	2	0	241.4	-4.5	0	0	.0732	0.2	.3155	
(20%)		0.05	221.7	15.3	20	0.084	.0738	19.9	.3182	
		0.10	201.7	35.2	40	0.169	.0739	39.9	.3185	
($\hat{y}$ =		0.15	181.8	55.2	60	0.253	.0740	59.8	.3190	
4.6')		0.25	141.8	95.1	100	0.422	.0740	99.7	.3192	
	2.5	0.05	221.3	15.6	20	0.084	.0710	20.3	.3062	
		0.10	201.1	35.9	40	0.169	.0693	40.5	.2985	
		0.15	180.9	56.0	60	0.253	.0680	60.7	.2930	
		0.25	140.6	96.4	100	0.422	.0661	101.0	.2851	
	3	0.05	220.9	16.0	20	0.084	.0685	20.7	.2953	
		0.10	200.4	36.6	40	0.169	.0651	41.2	.2808	
		0.15	179.9	57.0	60	0.253	.0628	61.6	.2706	
		0.25	139.4	97.6	100	0.422	.0598	102.2	.2576	
	4	0.05	219.9	17.1	20	0.084	.0638	21.7	.2748	
		0.10	198.8	38.2	40	0.169	.0581	42.8	.2504	
		0.15	178.0	58.9	60	0.253	.0544	63.5	.2346	
		0.25	137.0	100.0	100	0.422	.0500	104.6	.2154	
2	2	0	245.8	-8.9	0	0	.0722	0.4	.3113	
(10%)		0.05	225.9	11.0	20	0.084	.0726	20.3	.3128	
		0.10	206.0	30.9	40	0.169	.0728	40.2	.3138	
($\hat{y}$ =		0.15	186.1	50.9	60	0.253	.0731	60.1	.3150	
9.2')		0.25	146.2	90.8	100	0.422	.0734	100.0	.3163	
	2.5	0.05	225.4	11.6	20	0.084	.0699	20.8	.3012	
		0.10	205.1	31.9	40	0.169	.0683	41.1	.2944	
		0.15	184.9	52.1	60	0.253	.0672	61.3	.2898	
		0.25	144.4	92.5	100	0.422	.0656	101.8	.2828	
	3	0.05	224.8	12.1	20	0.084	.0674	21.3	.2907	
		0.10	204.2	32.8	40	0.169	.0644	42.0	.2774	
		0.15	183.6	53.3	60	0.253	.0622	62.5	.2681	
		0.25	142.8	94.1	100	0.422	.0593	103.4	.2556	
	4	0.05	223.5	13.4	20	0.084	.0628	22.7	.2709	
		0.10	202.1	34.8	40	0.169	.0574	44.0	.2476	
		0.15	181.2	55.7	60	0.253	.0540	65.0	.2326	
		0.25	139.9	97.1	100	0.422	.0497	106.3	.2140	
			($\overline{Q_d}$ = 10 mgd; E_{pd} = 149.3 Ft.)							
2	3	0.10	143.4	5.9	10	0.067	.0689	10.5	.2969	
(20%)	4	0.10	142.7	6.5	10	0.067	.0648	11.2	.2795	
($\hat{y}$ = 4.6')										
1	3	0.10	147.3	2.0	10	0.067	.0672	11.2	.2897	0.2'*
(10%)	4	0.10	146.4	2.9	10	0.067	.0635	12.1	.2735	
($\hat{y}$ = 9.2')										

(*: approximate run)

TABLE TRIA-1

Storage Equalization Computed Characteristics

Demand Schedule: Tri-Service Peak Day ($a/\overline{Q_d}$ = 0.232)

Specific Speed : N_s = 2,200 N = 1,150 rpm

V, mg	n	φ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 Ft.)						
4	2	0	249.1	-5.8	0	0	.0726	-0.1	.3130	0.2'*
(20%)		0.05	229.1	14.1	20	0.082	.0731	19.9	.3151	
		0.10	209.2	34.1	40	0.164	.0733	39.9	.3160	0.2'*
($\hat{y}$ =		0.15	189.2	54.1	60	0.247	.0734	59.8	.3165	
5.7')		0.25	149.2	94.1	100	0.411	.0735	99.8	.3170	
	2.5	0.05	228.5	14.8	20	0.082	.0688	20.5	.2964	
		0.10	208.1	35.2	40	0.164	.0665	40.9	.2868	
		0.15	187.8	55.4	60	0.247	.0652	61.2	.2810	
		0.25	147.4	95.9	100	0.411	.0635	101.7	.2737	
	3	0.05	227.8	15.5	20	0.082	.0647	21.2	.2791	
		0.10	207.1	36.2	40	0.164	.0609	41.9	.2624	
		0.15	186.5	56.7	60	0.247	.0585	62.5	.2522	
		0.25	145.8	97.5	100	0.411	.0558	103.2	.2407	
	4	0.05	226.3	17.0	20	0.082	.0577	22.7	.2486	
		0.10	205.1	38.2	40	0.164	.0518	43.9	.2231	
		0.15	184.3	59.0	60	0.247	.0485	64.7	.2090	
		0.25	143.1	100.2	100	0.411	.0448	105.9	.1932	
2	2	0	254.4	-11.2	0	0	.0692	0.3	.2981	0.9'*
(10%)		0.05	234.8	8.5	20	0.082	.0711	20.0	.3065	0.7'*
		0.10	214.9	28.4	40	0.164	.0721	39.9	.3106	0.6'*
($\hat{y}$ =		0.15	195.0	48.3	60	0.247	.0726	59.8	.3128	0.5'*
11.5')		0.25	155.1	88.2	100	0.411	.0731	99.7	.3150	0.4'*
	2.5	0.05	233.8	9.4	20	0.082	.0671	20.9	.2894	0.6'*
		0.10	213.4	29.9	40	0.164	.0656	41.4	.2829	0.5'*
		0.15	193.0	50.3	60	0.247	.0645	61.8	.2781	0.4'*
		0.25	152.3	90.9	100	0.411	.0630	102.4	.2717	0.2'*
	3	0.05	232.9	10.4	20	0.082	.0634	21.9	.2732	0.5'*
		0.10	211.9	31.4	40	0.164	.0600	42.9	.2588	0.4'*
		0.15	191.1	52.2	60	0.247	.0579	63.6	.2496	0.2'*
		0.25	150.0	93.3	100	0.411	.0553	104.8	.2384	0.2'*
	4	0.05	230.9	12.4	20	0.082	.0567	23.9	.2443	0.4'*
		0.10	209.1	34.2	40	0.164	.0511	45.7	.2201	0.2'*
		0.15	187.9	55.4	60	0.247	.0478	66.9	.2062	
		0.25	146.4	96.9	100	0.411	.0444	108.4	.1913	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)						
2	3	0.10	148.1	5.1	10	0.065	.0651	10.9	.2808	0.2'*
(20%)	~~4~~	~~0.10~~	~~147.1~~	~~6.1~~	~~10~~	~~0.065~~	~~.0590~~	~~11.9~~	~~.2543~~	
($\hat{y}$ = 5.7')										
1	3	0.10	152.9	0.4	10	0.065	.0612	11.8	.2639	1.0'*
(10%)	~~4~~	~~0.10~~	~~151.5~~	~~1.7~~	~~10~~	~~0.065~~	~~.0559~~	~~13.2~~	~~.2411~~	~~0.7'*~~
($\hat{y}$ = 11.5')										

(*: approximate runs).

TABLE TRIA-2

Storage Equalization Computed Characteristics

Demand Schedule: Tri-Service Peak Day ($a/\overline{Q_d}$ = 0.232)

Specific Speed : N_s = 3,000 N = 1,450 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 Ft.)						
4	2	0	224.9	-5.8	0	0	.0728	-0.1	.3137	0.2'*
(20%)		0.05	205.0	14.1	20	0.091	.0732	19.9	.3154	0.2'*
		0.10	185.0	34.1	40	0.183	.0734	39.9	.3162	
($\hat{y}$ =		0.15	165.0	54.1	60	0.274	.0734	59.9	.3166	
5.7')		0.25	125.1	94.0	100	0.456	.0736	99.8	.3173	
	2.5	0.05	204.4	14.8	20	0.091	.0690	20.5	.2975	0.2'*
		0.10	183.9	35.2	40	0.183	.0668	40.9	.2879	
		0.15	163.6	55.5	60	0.274	.0654	61.2	.2819	
		0.25	123.2	95.9	100	0.456	.0638	101.6	.2749	
	3	0.05	203.6	15.5	20	0.091	.0652	21.3	.2809	
		0.10	182.9	36.3	40	0.183	.0613	42.0	.2640	
		0.15	162.4	56.8	60	0.274	.0590	62.5	.2542	
		0.25	121.5	97.6	100	0.456	.0562	103.4	.2421	
	4	0.05	202.1	17.0	20	0.091	.0583	22.8	.2515	
		0.10	180.8	38.3	40	0.183	.0524	44.0	.2261	
		0.15	160.0	59.2	60	0.274	.0490	64.9	.2114	
		0.25	118.7	100.5	100	0.456	.0453	106.2	.1952	
2	2	0	230.3	-11.1	0	0	.0697	0.3	.3006	0.9'*
(10%)		0.05	210.6	8.5	20	0.091	.0714	20.3	.3077	0.7'*
		0.10	190.7	28.4	40	0.183	.0722	39.9	.3112	0.5'*
($\hat{y}$ =		0.15	170.8	48.3	60	0.274	.0727	50.8	.3132	0.4'*
11.5')		0.25	130.9	88.2	100	0.456	.0731	99.7	.3152	0.3'*
	2.5	0.05	209.7	9.5	20	0.091	.0675	20.9	.2910	0.6'*
		0.10	189.2	29.9	40	0.183	.0660	41.4	.2843	0.4'*
		0.15	168.8	50.3	60	0.274	.0648	61.8	.2794	0.3'*
		0.25	128.2	91.0	100	0.456	.0633	102.5	.2728	0.2'*
	3	0.05	208.7	10.4	20	0.091	.0639	21.9	.2754	0.5'*
		0.10	187.7	31.5	40	0.183	.0605	42.9	.2609	0.3'*
		0.15	166.9	52.2	60	0.274	.0583	63.7	.2514	0.2'*
		0.25	125.7	93.4	100	0.456	.0557	104.9	.2399	
	4	0.05	206.7	12.5	20	0.091	.0573	24.0	.2471	0.4'*
		0.10	184.8	34.3	40	0.183	.0517	45.8	.2228	
		0.15	163.6	55.5	60	0.274	.0484	67.0	.2087	
		0.25	122.0	97.2	100	0.456	.0448	108.7	.1933	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)						
2	3	0.10	132.9	5.1	10	0.072	.0656	10.9	.2826	0.2'*
(20%)	4	0.10	131.9	6.2	10	0.072	.0596	11.9	.2570	0.2'*
($\hat{y}$ = 5.7')										
1	3	0.10	137.7	0.4	10	0.072	.0619	11.9	.2667	0.9'*
(10%)	4	0.10	136.4	1.7	10	0.072	.0568	13.2	.2449	0.7'*
($\hat{y}$ = 11.5')										

(*: approximate runs).

TABLE TRIA-3

Storage Equalization Computed Characteristics

Demand Schedule: Tri-Service Peak Day ($a/\overline{Q_d} = 0.232$)

Specific Speed : $N_s = 4{,}000$ $N = 2{,}050$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y \div \hat{Y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 236.9 Ft.)						
4	2	0	242.8	-5.9	0	0	.0733	-0.1	.3161	
(20%)		0.05	222.8	14.1	20	0.084	.0734	19.9	.3165	
		0.10	202.8	34.1	40	0.169	.0735	39.9	.3168	
($\hat{Y}$ =		0.15	182.9	54.1	60	0.253	.0736	59.8	.3172	
5.7')		0.25	142.9	94.0	100	0.422	.0737	99.8	.3176	
	2.5	0.05	222.3	14.6	20	0.084	.0706	20.4	.3042	
		0.10	201.9	35.0	40	0.169	.0687	40.8	.2960	
		0.15	181.6	55.3	60	0.253	.0674	61.[illegible]	.2903	
		0.25	141.1	95.8	100	0.422	.0655	101.6	.2824	
	3	0.05	221.6	15.3	20	0.084	.0677	21.1	.2920	
		0.10	200.8	36.1	40	0.169	.0643	41.8	.2772	
		0.15	180.2	56.7	60	0.253	.0619	62.5	.2669	
		0.25	139.4	97.6	100	0.422	.0589	103.3	.2540	
	4	0.05	220.1	16.9	20	0.084	.0625	22.6	.2695	
		0.10	198.6	38.4	40	0.169	.0568	44.1	.2449	
		0.15	177.5	59.5	60	0.253	.0532	65.2	.2294	
		0.25	135.9	101.0	100	0.422	.0489	106.7	.2106	
2	2	0	248.5	-11.6	0	0	.0722	-0.1	.3114	0.5'*
(10%)		0.05	228.6	8.3	20	0.084	.0727	19.8	.3133	0.4'*
		0.10	208.7	28.2	40	0.169	.0729	39.7	.3144	0.4'*
($\hat{Y}$ =		0.15	188.7	48.2	60	0.253	.0731	59.7	.3152	0.3'*
11.5')		0.25	148.8	88.2	100	0.422	.0733	99.7	.3161	0.3'*
	2.5	0.05	227.9	9.1	20	0.084	.0699	20.5	.3011	0.4'*
		0.10	207.4	29.6	40	0.169	.0682	41.1	.2938	0.3'*
		0.15	186.9	50.0	60	0.253	.0669	61.5	.2883	0.2'*
		0.25	146.2	90.7	100	0.422	.0651	102.2	.2807	0.2'*
	3	0.05	227.0	9.9	20	0.084	.0671	21.4	.2892	0.4'*
		0.10	205.9	31.0	40	0.169	.0638	42.5	.2749	0.3'*
		0.15	185.0	51.9	60	0.253	.0615	63.4	.2649	0.2'*
		0.25	143.7	93.2	100	0.422	.0584	104.7	.2518	
	4	0.05	224.9	12.0	20	0.084	.0618	23.5	.2664	0.2'*
		0.10	202.8	34.1	40	0.169	.0562	45.6	.2422	
		0.15	181.4	55.6	60	0.253	.0526	67.1	.2268	
		0.25	139.5	97.5	100	0.422	.0484	108.9	.2088	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 149.3 Ft.)						
2	3	0.10	144.3	4.9	10	0.067	.0683	10.7	.2944	
(20%)	4	0.10	143.3	5.9	10	0.067	.0637	11.7	.2745	
($\hat{Y}$ = 5.7')										
1	3	0.10	149.6	-0.3	10	0.067	.0664	11.2	.2864	0.6'*
(10%)	4	0.10	148.3	1.0	10	0.067	.0622	12.5	.2680	0.5'*
($\hat{Y}$ = 11.5')										

(*: approximate run)

TABLE BS-1

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.353$

Specific Speed : $N_s = 2,200$ N = (See Table)

Mean Demand : $\overline{Q_d}$ = (See Table) E_{pd} = (See Table)

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
			($\overline{Q_d}$ = 10 mgd; N = 1,450 rpm; E_{pd} = 208.8 Ft.)							
2	2	0	215.5	-6.7	0	0	.1099	0.3	.3113	
(20%)		0.05	210.5	-1.7	5	0.024	.1101	5.3	.3119	
		0.10	205.6	3.2	10	0.048	.1104	10.2	.3128	
($\hat{y}$ =		0.40	175.8	33.0	40	0.192	.1116	40.0	.3162	
7.0')		0.90	125.9	82.8	90	0.431	.1122	89.8	.3179	
	3	0.05	209.9	-1.1	5	0.024	.1055	5.9	.2989	
		0.10	204.5	4.2	10	0.048	.1025	11.2	.2904	
		0.40	172.9	35.9	40	0.192	.0917	42.9	.2598	
		0.90	121.3	87.4	90	0.431	.0851	94.4	.2411	
	4	0.05	209.0	-0.3	5	0.024	.1008	6.7	.2856	
		0.10	203.2	5.6	10	0.048	.0950	12.6	.2691	
		0.40	170.2	38.6	40	0.192	.0775	45.6	.2196	
		0.90	117.6	91.1	90	0.431	.0683	98.1	.1935	
1	2	0	221.3*	-12.5*	0	0	.1045*	1.5*	.2960*	0.8'
(10%)		0.05	216.5*	-7.8*	5	0.024	.1057*	6.2*	.2994*	0.7'
		0.10	211.7*	-3.0*	10	0.048	.1067*	11.0*	.3023*	0.6'
($\hat{y}$ =		0.40	182.2*	26.5*	40	0.192	.1094*	40.5*	.3099*	0.3'
14.0')		0.90	132.4	76.3	90	0.431	.1105	90.3	.3130	
	3	0.05	215.8*	-7.0*	5	0.024	.1018*	7.0*	.2884*	0.6'
		0.10	210.3*	-1.6*	10	0.048	.0995*	12.4*	.2819*	0.4'
		0.40	178.2	30.6	40	0.192	.0903	44.6	.2558	
		0.90	126.3	82.5	90	0.431	.0842	96.5	.2385	
	4	0.05	214.8*	-6.0*	5	0.024	.0978*	8.0*	.2771*	0.5'
		0.10	208.6*	0.2*	10	0.048	.0926*	13.8*	.2623*	0.3'
		0.40	174.7	34.0	40	0.192	.0768	48.0	.2176	
		0.90	121.6	87.1	90	0.431	.0677	101.1	.1918	
			($\overline{Q_d}$ = 20 mgd; N = 1150 rpm; E_{pd} = 243.3 Ft.)							
4	3	0.10	207.4	35.8	40	0.164	.0932	42.8	.2640	
(20%)	4	0.10	204.6	38.7	40	0.164	.0796	45.7	.2255	
2	3	0.10	212.9	30.4	40	0.164	.0920	44.4	.2606	
(10%)	4	0.10	209.3	34.0	40	0.164	.0789	48.0	.2235	

(*: approximate run).

TABLE BS-2

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.353$

Specific Speed : $N_s = 3{,}000$ N = (See Table)

Mean Demand : $\overline{Q_d}$ = (See Table) E_{pd} = (See Table)

V, mg	n	φ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
			($\overline{Q_d}$ = 20 mgd; N = 1,450 rpm; E_{pd} = 219.1 Ft.)							
4	2	0	225.9	-6.8	0	0	.1106	0.2	.3133	
(20%)		0.05	206.0	13.1	20	0.091	.1113	20.1	.3153	
($\hat{y}$ =		0.25	126.4	92.8	100	0.456	.1124	99.8	.3184	
7.0')		0.50	26.5	192.6	200	0.913	.1126	199.6	.3190	
	4	0	225.9	-6.8	0	0	.1106	0.2	.3133	
		0.05	202.2	17.0	20	0.091	.0898	24.0	.2544	
		0.25	117.0	102.2	100	0.456	.0696	109.2	.1972	
		0.50	13.2	205.9	200	0.913	.0637	212.9	.1801	
2	2	0	232.0	-12.8*	0	0	.1072*	1.2*	.3037*	0.6'
(10%)		0.05	212.6*	6.5*	20	0.091	.1095*	20.5*	.3102*	0.5'
($\hat{y}$ =		0.25	132.9	86.2	100	0.456	.1111	100.2	.3147	
14.0')		0.50	33.2	186.0	200	0.913	.1119	200.0	.3170	
	4	0	232.0	-12.8*	0	0	.1072	1.2*	.3037*	0.6'
		0.05	207.2	11.9	20	0.091	.0885	25.9	.2507	
		0.25	121.0	98.1	100	0.456	.0691	112.1	.1958	
		0.50	16.8	202.3	200	0.913	.0634	216.3	.1796	
			($\overline{Q_d}$ = 10 mgd; N = 1,450 rpm; E_{pd} = 138.0 Ft.)							
2	3	0.05	139.0	-1.0	5	0.036	.1040	6.0	.2946	
(20%)		0.10	133.6	4.4	10	0.072	.1004	11.4	.2844	
		0.40	102.1	36.0	40	0.290	.0895	43.0	.2535	
($\hat{y}$ =		0.90	50.5	87.5	90	0.652	.0833	94.5	.2360	
7.0')	4	0.10	132.3	5.8	10	0.072	.0920	12.8	.2606	
		0.40	99.5	38.6	40	0.290	.0744	45.6	.2108	
1	3	0.05	144.3*	-6.3*	5	0.036	.0980*	7.7*	.2776*	0.7'
(10%)		0.10	139.0*	-0.9*	10	0.072	.0961*	13.1*	.2722*	0.6'
		0.40	107.1	30.9	40	0.290	.0879	44.9	.2490	
($\hat{y}$ =		0.90	55.4	82.6	90	0.652	.0824	96.6	.2334	
14.0')	4	0.10	137.3*	0.7*	10	0.072	.0887*	14.7*	.2513*	0.4'
		0.40	103.8	34.2	40	0.290	.0737	48.2	.2088	

(*: approximate run).

TABLE BS-3

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.353$

Specific Speed : $N_s = 4,000$ N = (See Table)

Mean Demand : $\overline{Q_d}$ = (See Table) E_{pd} = (See Table)

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 10 mgd; N = 1,750 rpm; E_{pd} = 120.9 Ft.)										
2 (20%) ($\hat{y}$ = 7.0')	2	0	127.5	-6.7	0	0	.1100	0.3	.3116	
		0.05	122.6	-1.7	5	0.041	.1101	5.3	.3119	
		0.10	117.7	3.2	10	0.083	.1105	10.2	.3130	
		0.40	87.9	33.0	40	0.331	.1116	40.0	.3162	
		0.90	38.0	82.8	90	0.745	.1122	89.8	.3179	
	3	0.05	122.0	-1.1	5	0.041	.1056	5.9	.2992	
		0.10	116.6	4.2	10	0.083	.1026	11.2	.2907	
		0.40	85.0	35.9	40	0.331	.0919	42.9	.2603	
		0.90	33.0	87.6	90	0.745	.0852	94.6	.2414	
	4	0.05	121.1	-0.2	5	0.041	.1010	6.8	.2861	
		0.10	115.3	5.6	10	0.083	.0952	12.6	.2697	
		0.40	82.2	38.7	40	0.331	.0778	45.7	.2204	
		0.90	29.6	91.3	90	0.745	.0685	98.3	.1941	
1 (10%) ($\hat{y}$ = 14.0')	2	0	133.3*	-12.4*	0	0	.1048*	1.6*	.2969*	0.7'
		0.05	128.6*	-7.7*	5	0.041	.1060*	6.3*	.3003*	0.7'
		0.10	123.8*	-2.9*	10	0.083	.1068*	11.1*	.3026*	0.6'
		0.40	94.3*	26.6*	40	0.331	.1094*	40.6*	.3099*	0.3'
		0.90	44.5	76.4	90	0.745	.1105	90.4	.3130	
	3	0.05	127.8*	-7.0*	5	0.041	.1021*	7.0*	.2892*	0.5'
		0.10	122.4*	-1.5*	10	0.083	.0997*	12.5*	.2824*	0.5'
		0.40	90.2	30.7	40	0.331	.0905	44.7	.2564	
		0.90	38.3	82.6	90	0.745	.0844	96.6	.2391	
	4	0.05	126.8*	-6.0*	5	0.041	.0981*	8.0*	.2779*	0.4'
		0.10	120.6*	0.2*	10	0.083	.0929*	13.8*	.2632*	0.3'
		0.40	86.7	34.1	40	0.331	.0771	48.1	.2184	
		0.90	33.6	87.3	90	0.745	.0680	101.3	.1926	
($\overline{Q_d}$ = 20 mgd; N = 1,750 rpm; E_{pd} = 191.9 Ft.)										
4 (20%)	3	0.10	156.1	35.8	40	0.208	.0965	42.8	.2734	
	4	0.10	152.8	39.1	40	0.208	.0842	46.1	.2385	
2 (10%)	3	0.10	161.7	30.1	40	0.208	.0953	44.1	.2700	
	4	0.10	157.8	34.1	40	0.208	.0835	48.1	.2365	

(*: approximate run).

TABLE BS-4**

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.394$

Specific Speed : $N_s = 3,000$ $N = 1,450$ rpm

Mean Demand : $\overline{Q_d} = 20$ mgd $E_{pd} = 219.1$ ft.

V, mg	n	Φ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
4	2	0	226.7	-7.5	0	0	.1234	9.3	.3132	
(20%)		0.05	206.9	12.3	20	0.091	.1244	20.1	.3157	
		0.25	127.1	92.0	100	0.456	.1254	99.8	.3183	
($\hat{y}$ =		0.50	27.4	191.8	200	0.913	.1257	199.6	.3190	
7.8')	4	0	226.7	-7.5	0	0	.1234	0.3	.3132	
		0.05	202.0	17.1	20	0.091	.0997	24.9	.2531	
		0.25	115.6	103.5	100	0.456	.0772	111.3	.1959	
		0.50	11.0	208.2	200	0.913	.0707	216.0	.1794	
2	2	0	233.4*	-14.3*	0	0	.1197*	1.4*	.3038*	0.6'
(10%)		0.05	213.9*	5.3*	20	0.091	.1218*	21.0*	.3091*	0.4'
		0.25	134.5	84.7	100	0.456	.1239	100.4	.3145	
($\hat{y}$ =		0.50	34.8	184.4	200	0.913	.1249	200.1	.3170	
15.7')	4	0	233.4*	-14.3*	0	0	.1197*	1.4*	.3038*	0.6'
		0.05	207.7	11.4	20	0.091	.0984	27.1	.2498	
		0.25	120.2	99.0	100	0.456	.0768	114.7	.1949	
		0.50	14.9	204.2	200	0.913	.0704	219.9	.1787	

(*: approximate run).

**(NOTE: Special Series, used to see if better than rationale for Belmont H.S. Typical Day with $a/\overline{Q_d} = 0.353$).

TABLE BS-5

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d}$ = 0.353

n = 2.5, only

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
(N_s = 2,200; $\overline{Q_d}$ = 20 mgd; N = 1,150 rpm; E_{pd} = 243.3 Ft.)										
4	2.5	0.05	229.4	13.9	20	0.082	.1049	20.9	.2971	
(20%)		0.10	209.0	34.3	40	0.164	.1018	41.3	.2885	
($\hat{y}$ =		0.15	188.6	54.7	60	0.247	.0998	61.7	.2826	
7.0')		0.25	147.8	95.4	100	0.411	.0971	102.4	.2752	
2	2.5	0.05	235.4	7.8	20	0.082	.1028	21.9	.2912	0.2'*
(10%)		0.10	214.8	28.5	40	0.164	.1001	42.5	.2836	
($\hat{y}$ =		0.15	194.3	49.0	60	0.247	.0983	63.0	.2784	
14.0')		0.25	153.6	89.7	100	0.411	.0962	103.7	.2725	
(N_s = 3,000; $\overline{Q_d}$ = 20 mgd; N = 1,450 rpm; E_{pd} = 219.1 Ft.)										
4	2.5	0.05	205.3	13.9	20	0.091	.1054	20.9	.2985	
(20%)		0.10	184.7	34.4	40	0.183	.1022	41.4	.2895	
		0.15	164.3	54.8	60	0.274	.1001	61.8	.2836	
		0.25	123.7	95.4	100	0.456	.0976	102.5	.2764	
2	2.5	0.05	211.2	7.9	20	0.091	.1033	21.9	.2927	0.2'*
(10%)		0.10	190.6	28.6	40	0.183	.1006	42.6	.2849	
		0.15	170.1	49.0	60	0.274	.0988	63.0	.2798	
		0.25	129.4	89.7	100	0.456	.0966	103.8	.2737	
(N_s = 4,000; $\overline{Q_d}$ = 20 mgd; N = 1,750 rpm; E_{pd} = 191.9 Ft.)										
4	2.5	0.05	178.1	13.8	20	0.104	.1068	20.8	.3025	
(20%)		0.10	157.6	34.3	40	0.208	.1038	41.3	.2941	
		0.15	137.2	54.7	60	0.313	.1017	61.7	.2881	
		0.25	96.5	95.4	100	0.521	.0990	102.4	.2805	
2	2.5	0.05	184.2	7.6	20	0.104	.1050	21.7	.2974	
(10%)		0.10	163.6	28.3	40	0.208	.1023	42.3	.2898	
		0.15	143.1	48.7	60	0.313	.1005	62.8	.2846	
		0.25	102.3	89.5	100	0.521	.0982	103.6	.2782	

(*: approximate run)

TABLE BA-1

Storage Equalization Computed Characteristics

Demand Schedule: Belmont H.S. Typical Day. $(a/\overline{Q}_d = 0.353)$

Specific Speed : $N_s = 3{,}000$ $N = 1{,}450$ rpm

Mean Demand : $\overline{Q}_d = 10$ mgd $E_{pd} + 138.1$ ft.

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q}_d^{\,2}$	$\phi\overline{Q}_d^{\,2}/E_{pd}$	$U/\overline{Q}_d$	$E_{pd} - Y + \hat{y}$	U/a
2.00	2	0.08	138.0	0.1	8	0.058	.1126	7.9	.3190
$(V/\overline{Q}_d$		0.16	130.0	8.1	16	0.116	.1127	15.9	.3193
=20%)		0.32	114.1	24.0	32	0.232	.1131	31.8	.3204
		0.64	82.1	56.0	64	0.463	.1132	63.8	.3207
$(\hat{y}$ =		1.28	18.2	119.9	128	0.927	.1133	127.7	.3210
7.8')	2.5	0.04	141.6	-3.5	4	0.029	.1093	4.3	.3096
		0.32	112.4	25.7	32	0.232	.1007	33.5	.2853
		1.28	14.3	123.8	128	0.927	.0933	131.6	.2643
	3	0.04	141.2	-3.1	4	0.029	.1066	4.7	.3020
		0.08	136.7	1.4	8	0.058	.1027	9.2	.2909
		0.16	127.9	10.2	16	0.116	.0970	18.0	.2748
		0.32	110.7	27.4	32	0.232	.0901	35.2	.2552
		0.64	77.3	60.8	64	0.463	.0837	68.6	.2371
	3.5	0.02	143.2	-5.1	2	0.014	.1069	2.7	.3028
		0.08	135.9	2.2	8	0.058	.0978	10.0	.2771
		0.64	75.3	62.8	64	0.463	.0738	70.6	.2091
	4	0.02	142.8	-4.7	2	0.014	.1049	3.1	.2972
		0.04	140.2	-2.1	4	0.029	.1002	5.7	.2839
		0.08	135.0	3.1	8	0.058	.0929	10.9	.2632
		0.16	125.5	12.6	16	0.116	.0835	20.4	.2365
		0.32	107.8	30.3	32	0.232	.0740	38.1	.2096
1.75	2	0.08	139.1	-1.0	8	0.058	.1121	7.9	.3176
$(V/\overline{Q}_d$		0.32	115.2	22.9	32	0.232	.1129	31.8	.3198
=17.5%)		1.28	19.3	118.8	128	0.927	.1132	127.7	.3207
	3	0.04	142.2	-4.1	4	0.029	.1062	4.8	.3009
$(\hat{y}$ =		0.16	128.8	9.3	16	0.116	.0968	18.2	.2742
8.9')		0.64	78.1	60.0	64	0.463	.0837	68.9	.2371
	4	0.02	143.9	-5.8	2	0.014	.1045	3.1	.2960
		0.08	135.9	2.2	8	0.058	.0926	11.1	.2623
		0.32	108.5	29.6	32	0.232	.0740	38.5	.2096

TABLE BA-2

Storage Equalization Computed Characteristics

Demand Schedule: Belmont H.S. Typical Day. $(a/\overline{Q}_d = 0.353)$

Specific Speed : $N_s = 3,000$ $N = 1,450$ rpm

Mean Demand : $\overline{Q}_d = 10$ mgd $E_{pd} = 138.1$ ft.

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q}_d^2$	$\phi\overline{Q}_d^2/E_{pd}$	$U/\overline{Q}_d$	$E_{pd} - Y + \hat{y}$	U/a
1.50	2	0.08	140.5	-2.4	8	0.058	.1113	8.0	.3153
$(V/\overline{Q}_d$		0.32	116.7	21.4	32	0.232	.1126	31.8	.3190
=15%)		1.28	20.8	117.3	128	0.927	.1132	127.7	.3207
	3	0.04	143.6	-5.5	4	0.029	.1053	4.9	.2983
$(\hat{y}$ =		0.16	130.1	8.0	16	0.116	.0965	18.4	.2734
10.4')		0.64	74.8	63.3	64	0.463	.0835	73.7	.2365
	4	0.02	145.2	-7.1	2	0.014	.1038	3.3	.2941
		0.08	137.2	0.9	8	0.058	.0922	11.3	.2612
		0.32	109.5	28.6	32	0.232	.0740	39.0	.2096
1.25	2	0.08	142.4	-4.3	8	0.058	.1096	8.2	.3105
$(V/\overline{Q}_d$		0.32	118.8	19.3	32	0.232	.1122	31.8	.3179
=12.5%)		1.28	22.9	115.2	128	0.927	.1130	127.7	.3201
	3	0.04	145.3	-7.2	4	0.029	.1036	5.3	.2935
$(\hat{y}$ =		0.16	131.8	6.3	16	0.116	.0959	18.8	.2717
12.5')		0.64	80.7	57.4	64	0.463	.0837	69.9	.2371
	4	0.02	147.0	-8.9	2	0.014	.1022	3.6	.2895
		0.08	138.8	-0.7	8	0.058	.0915	11.8	.2592
		0.32	110.9	27.2	32	0.232	.0739	39.7	.2094
1.00	2	0.08	145.0	-6.9	8	0.058	.1066	8.7	.3020
$(V/\overline{Q}_d$		0.32	121.7	16.4	32	0.232	.1109	32.0	.3142
=10%)		1.28	26.1	112.0	128	0.927	.1129	127.6	.3198
	3	0.04	147.9	-9.8	4	0.029	.1008	5.8	.2856
$(\hat{y}$ =		0.16	134.4	3.7	16	0.116	.0947	19.3	.2683
15.6')		0.64	83.1	55.0	64	0.463	.0837	70.6	.2371
	4	0.02	149.5	-11.4	2	0.014	.0991	4.2	.2807
		0.08	141.3	-3.2	8	0.058	.0901	12.4	.2552
		0.32	113.0	25.1	32	0.232	.0738	40.7	.2091
0.75	2	0.08	149.0	-10.9	8	0.058	.1002	10.0	.2838
$(V/\overline{Q}_d$		0.32	126.5	11.6	32	0.232	.1081	32.4	.3062
=7.5%)		1.28	31.3	106.8	128	0.927	.1127	127.6	.3193
	3	0.04	151.6	-13.5	4	0.029	.0948	7.3	.2686
$(\hat{y}$ =		0.16	138.5	-0.4	16	0.116	.0919	20.4	.2603
20.8')		0.64	87.1	51.0	64	0.463	.0834	71.8	.2363
	4	0.02	153.1	-15.0	2	0.014	.0930	5.8	.2635
		0.08	145.1	-7.0	8	0.058	.0868	13.8	.2459
		0.32	116.5	21.6	32	0.232	.0733	42.4	.2077

TABLE BA-3

Storage Equalization Computed Characteristics

Demand Schedule: Belmont H.S. Typical Day. ($a/\overline{Q}_d = 0.353$)

Specific Speed : $N_s = 3,000$ $N = 875$ rpm

Mean Demand : $\overline{Q}_d + 10$ mgd $E_{pd} = 70.4$ ft.

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q}_d^2$	$\phi\overline{Q}_d^2/E_{pd}$	$U/\overline{Q}_d$	$E_{pd} - Y + \hat{y}$	U/a
2.00 ($V/\overline{Q}_d$ = 20%)	2	0.08	70.1	0.3	8	0.114	.1089	8.1	.3085
		0.16	62.3	8.1	16	0.227	.1111	15.9	.3147
		0.32	46.4	24.0	32	0.455	.1126	31.8	.3190
		1.28	-49.5	119.9	128	1.818	.1133	127.7	.3210
($\hat{y}$ = 7.8')	3	0.04	73.1	-2.7	4	0.057	.0990	5.1	.2805
		0.08	68.6	1.8	8	0.114	.0951	9.6	.2694
		0.16	59.9	10.5	16	0.227	.0899	18.3	.2547
		0.64	9.8	60.6	64	0.909	.0792	68.4	.2244
	4	0.02	74.7	-4.3	2	0.028	.0960	3.5	.2720
		0.08	67.1	3.3	8	0.114	.0829	11.1	.2348
		0.32	40.6	29.8	32	0.455	.0664	37.6	.1881
1.75 ($V/\overline{Q}_d$ =17.5%)	2	0.08	71.1	-0.7	8	0.114	.1072	8.2	.3037
		0.16	63.3	7.1	16	0.227	.1100	16.0	.3116
		0.32	47.5	22.9	32	0.455	.1122	31.8	.3179
($\hat{y}$ = 8.9')	3	0.04	74.0	-3.6	4	0.057	.0972	5.3	.2754
		0.08	69.5	0.9	8	0.114	.0941	9.8	.2666
		0.16	60.8	9.6	16	0.227	.0895	18.5	.2535
	4	0.02	75.6	-5.2	2	0.028	.0943	3.7	.2671
		0.08	67.9	2.5	8	0.114	.0823	11.4	.2331
		0.32	41.2	29.2	32	0.455	.0664	38.1	.1881
1.50 ($V/\overline{Q}_d$ =15%)	2	0.08	72.2	-1.8	8	0.114	.1044	8.6	.2958
		0.16	64.6	5.8	16	0.227	.1083	16.2	.3068
		0.32	48.9	21.5	32	0.455	.1115	31.9	.3159
($\hat{y}$ = 10.4')	3	0.04	75.0	-4.6	4	0.057	.0945	5.8	.2677
		0.08	70.6	-0.2	8	0.114	.0923	10.2	.2615
		0.16	62.0	8.4	16	0.227	.0887	18.8	.2513
	4	0.02	76.6	-6.2	2	0.028	.0914	4.2	.2589
		0.08	69.0	1.4	8	0.114	.0812	11.8	.2300
		0.32	42.1	28.3	32	0.455	.0663	38.7	.1878
1.25 ($V/\overline{Q}_d$ =12.5%)	2	0.08	73.7	-3.3	8	0.114	.1001	9.2	.2826
		0.16	66.4	4.0	16	0.227	.1054	16.5	.2986
		0.32	50.9	19.5	32	0.455	.1101	32.0	.3119
($\hat{y}$ = 12.5')	3	0.04	76.4	-6.0	4	0.057	.0902	6.5	.2555
		0.08	72.1	-1.7	8	0.114	.0895	10.8	.2535
		0.16	63.5	6.9	16	0.227	.0872	19.4	.2470

TABLE BA-4

Storage Equalization Computed Characteristics

Demand Schedule: Belmont H.S. Typical Day. $(a/\overline{Q_d} = 0.353)$

Specific Speed : $N_s = 3{,}000$ N: (See Table)

Mean Demand : $\overline{Q_d} = 20$ mgd E_{pd}: (See Table)

(N = 1,450 rpm; E_{pd} = 219.1 Ft.)

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a
4.00	2	0.05	207.2	11.9	20	0.091	.1130	19.7	.3201
$(V/\overline{Q_d}$		0.25	127.3	91.8	100	0.456	.1133	99.6	.3210
=20%)		0.50	27.5	191.6	200	0.913	.1133	199.4	.3210
	3	0.05	204.8	14.3	20	0.091	.0992	22.1	.2810
$(\hat{y}$ =		0.25	120.8	98.3	100	0.456	.0838	106.1	.2374
7.8')		0.50	17.8	201.3	200	0.913	.0790	209.1	.2238
	4	0.05	201.9	17.2	20	0.091	.0867	25.0	.2456
		0.25	115.9	103.2	100	0.456	.0659	111.0	.1867
		0.50	11.5	207.6	200	0.913	.0603	215.4	.1708
2.00	2	0.05	214.9	4.2	20	0.091	.1118	19.8	.3167
$(V/\overline{Q_d}$		0.25	135.2	83.9	100	0.456	.1128	99.5	.3196
=10%)		0.50	35.2	183.9	200	0.913	.1130	199.5	.3201
	3	0.05	211.6	7.5	20	0.091	.0985	23.1	.2793
$(\hat{y}$ =		0.25	126.6	92.5	100	0.456	.0837	108.1	.2371
15.6')		0.50	23.0	196.1	200	0.913	.0788	211.7	.2232
	4	0.05	208.0	11.1	20	0.091	.0865	26.7	.2450
		0.25	120.4	98.7	100	0.456	.0660	114.3	.1870
		0.50	15.4	203.7	200	0.913	.0602	219.3	.1705

(N = 875 rpm; E_{pd} = 111.8 Ft.)

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a
4.00	2	0.05	99.7	12.1	20	0.179	.1127	19.9	.3193
$(V/\overline{Q_d}$		0.25	19.9	91.9	100	0.894	.1133	99.7	.3210
=20%)		0.50	-80.0	191.8	200	1.789	.1133	199.6	.3210
$(\hat{y}$ =	3	0.05	97.2	14.6	20	0.179	.0927	22.4	.2626
7.8')		0.25	13.9	97.9	100	0.894	.0792	105.7	.2244
	4	0.05	94.8	17.0	20	0.179	.0775	24.8	.2196
		0.25	10.1	101.7	100	0.894	.0605	109.6	.1717
2.00	2	0.05	107.0	4.8	20	0.179	.1077	20.4	.3051
(10%)	3	0.05	103.5	8.3	20	0.179	.0904	23.9	.2561
$(\hat{y}$ =		0.50	-83.9	195.7	200	1.789	.0758	211.3	.2147
15.6')	4	0.05	100.2	11.6	20	0.179	.0766	27.2	.2170

TABLE BA-5

Storage Equalization Computed Characteristics

Demand Schedule: Belmont H.S. Typical Day. ($a/\overline{Q_d}$ = 0.353)

Specific Speed : N_s = 4,000 N: (See Table)

Mean Demand : $\overline{Q_d}$ = 10 mgd E_{pd}: (See Table)

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^{-2}$	$\phi\overline{Q_d}^{-2}/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a
				(N = 1,750 rpm; E_{pd} = 120.9 Ft.)					
2.00	2	0.05	123.8	-3.0	5	0.041	.1128	4.8	.3196
($V/\overline{Q_d}$		0.10	118.9	2.0	10	0.083	.1130	9.8	.3201
=20%)		0.40	89.0	31.9	40	0.331	.1131	39.7	.3204
		0.90	39.0	81.9	90	0.745	.1133	89.7	.3210
($\hat{y}$ =	2.5	0.05	123.5	-2.6	5	0.041	.1101	5.2	.3119
7.8')		0.10	118.2	2.6	10	0.083	.1081	10.4	.3062
		0.40	87.1	33.8	40	0.331	.1007	41.6	.2853
	3	0.05	123.1	-2.2	5	0.041	.1073	5.6	.3040
		0.10	117.4	3.5	10	0.083	.1031	11.3	.2921
		0.40	85.2	35.7	40	0.331	.0904	43.5	.2561
		0.90	33.1	87.8	90	0.745	.0830	95.6	.2351
	4	0.05	121.8	-0.9	5	0.041	.1009	6.9	.2858
		0.10	115.5	5.4	10	0.083	.0933	13.2	.2643
		0.40	81.7	39.2	40	0.331	.0742	47.0	.2102
		0.90	28.7	92.2	90	0.745	.0649	100.0	.1839
1.00	2.5	0.05	130.7	-9.9	5	0.041	.1066	5.7	.3020
($V/\overline{Q_d}$		0.10	125.5	-4.6	10	0.083	.1056	11.0	.2992
=10%)		0.40	94.1	26.8	40	0.331	.1003	42.4	.2841
		0.90	42.6	78.3	90	0.745	.0959	93.9	.2717
($\hat{y}$ =	4	0.05	128.6	-7.7	5	0.041	.0984	7.9	.2788
15.6')		0.10	122.0	-1.1	10	0.083	.0920	14.5	.2606
		0.40	86.9	34.0	40	0.331	.0742	49.6	.2102
		0.90	33.1	87.8	90	0.745	.0650	103.4	.1841
				(N = 1,150 rpm; E_{pd} = 69.1 Ft.)					
2.00	2.5	0.10	66.2	2.9	10	0.145	.1048	10.7	.2969
(20%)		0.40	35.1	33.9	40	0.579	.0976	41.7	.2765
	4	0.10	63.5	5.6	10	0.145	.0855	13.4	.2422
		0.40	30.4	38.6	40	0.579	.0676	46.4	.1915
				(N = 1,450 rpm; E_{pd} = 94.0 Ft.)					
2.00	2.5	0.90	9.0	85.0	90	0.957	.0948	92.8	.2686

TABLE BA-6

Storage Equilization Computed Characteristics

Demand Schedule: Belmont H.S. Typical Day. ($a/\overline{Q}_d$ = 0.353)

Specific Speed : N_s = 4,000 N = 1,750 rpm

Mean Demand : Q_d = 20 mgd E_{pd} = 191.9 ft.

V, mg	n	φ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q}_d^2$	$\phi\overline{Q}_d^2/E_{pd}$	$U/\overline{Q}_d$	E_{pd} - Y + $\hat{y}$	U/ə
4.00 ($V/\overline{Q}_d$ =20%)	2	0	199.9	-8.0	0	0	.1129	-0.2	.3198
		0.025	189.9	2.0	10	0.052	.1130	9.8	.3201
		0.10	159.9	31.9	40	0.208	.1132	39.7	.3207
		0.20	120.0	71.8	80	0.417	.1133	79.6	.3210
		0.40	40.1	151.8	160	0.834	.1132	159.6	.3207
($\hat{y}$ = 7.8')	2.5	0.025	189.4	2.5	10	0.052	.1098	10.3	.3111
		0.10	158.2	33.7	40	0.208	.1037	41.5	.2938
		0.20	117.1	74.7	80	0.417	.0994	82.5	.2816
		0.40	35.5	156.4	160	0.834	.0954	164.2	.2703
	3	0.025	188.6	3.2	10	0.052	.1062	11.0	.3009
		0.10	156.2	35.6	40	0.208	.0950	43.4	.2691
		0.20	114.3	77.6	80	0.417	.0881	85.4	.2496
		0.40	31.4	160.4	160	0.834	.0821	168.2	.2326
	4	0.025	186.6	5.3	10	0.052	.0985	13.1	.2790
		0.10	152.1	39.8	40	0.208	.0804	47.6	.2278
		0.20	109.1	82.8	80	0.417	.0711	90.6	.2014
		0.40	24.9	166.9	160	0.834	.0638	174.7	.1807
2.00 ($V/\overline{Q}_d$ =10%)	2	0.10	167.8	24.1	40	0.208	.1127	39.7	.3193
		0.20	127.9	64.0	80	0.417	.1128	79.6	.3196
		0.40	47.9	144.0	160	0.834	.1130	159.6	.3201
($\hat{y}$ = 15.6')	2.5	0.10	165.4	26.5	40	0.208	.1033	42.1	.2926
		0.20	124.0	67.8	80	0.417	.0992	83.4	.2810
		0.40	42.0	149.9	160	0.834	.0952	165.5	.2697
	3	0.10	162.8	29.0	40	0.208	.0949	44.6	.2688
		0.20	120.3	71.6	80	0.417	.0880	87.2	.2493
		0.40	36.9	154.9	160	0.834	.0819	170.5	.2320
	4	0.10	157.7	34.2	40	0.208	.0805	49.8	.2281
		0.20	113.8	78.0	80	0.417	.0711	93.6	.2014
		0.40	29.1	162.8	160	0.834	.0637	178.4	.1805

(N_s = 4.000; N = 1.450 rpm
$\overline{Q}_d$ = 20 mgd; E_{pd} = 149.3 Ft.)

2.00 (10%)	2	0	164.8	-15.5	0	0	.1103	0.1	.3125
	4	0	164.8	-15.5	0	0	.1103	0.1	.3125

TABLE BA-7

Storage Equalization Computed Characteristics

Demand Schedule: Belmont H.S. Typical Day. ($a/\overline{Q_d}$ = 0.353)

Specific Speed : N_s = 2,200   N = 1,450 rpm

Mean Demand : $\overline{Q_d}$ = 10 mgd E_{pd} = 208.8 ft.

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a
2.00	2	0	216.7	-8.0	0	0	.1127	-0.2	.3193
($V/\overline{Q_d}$		0.05	211.8	-3.0	5	0.024	.1129	4.8	.3198
=20%)		0.10	206.8	2.0	10	0.048	.1130	9.8	.3201
		0.40	176.8	31.9	40	0.192	.1131	39.7	.3204
($\hat{y}$ =		0.90	126.9	81.9	90	0.431	.1133	89.7	.3210
7.8')		1.80	37.0	171.8	180	0.862	.1132	179.6	.3207
	2.5	0.05	211.4	-2.7	5	0.024	.1102	5.1	.3122
		0.10	206.1	2.6	10	0.048	.1081	10.4	.3062
		0.40	175.0	33.8	40	0.192	.1006	41.6	.2850
		0.90	123.8	85.0	90	0.431	.0960	92.8	.2720
		1.80	32.2	176.6	180	0.862	.0929	184.4	.2632
	3	0.05	211.0	-2.2	5	0.024	.1072	5.6	.3037
		0.10	205.3	3.4	10	0.048	.1030	11.2	.2918
		0.40	173.1	35.7	40	0.192	.0902	43.5	.2555
		0.90	121.0	87.7	90	0.431	.0828	95.5	.2346
		1.80	28.3	180.5	180	0.862	.0783	188.3	.2218
	4	0	216.7	-8.0	0	0	.1127	-0.2	.3193
		0.05	209.7	-1.0	5	0.024	.1008	6.8	.2856
		0.10	203.4	5.3	10	0.048	.0931	13.1	.2637
		0.40	169.7	39.1	40	0.192	.0740	46.9	.2096
		0.90	116.7	92.1	90	0.431	.0646	99.9	.1830
		1.80	22.7	186.0	180	0.862	.0595	193.8	.1686
1.00	2	0	224.0	-15.2	0	0	.1078	0.4	.3054
($V/\overline{Q_d}$		0.05	219.1	-10.4	5	0.024	.1088	5.2	.3082
=10%)		0.10	214.3	-5.5	10	0.048	.1097	10.1	.3108
		0.40	184.7	24.1	40	0.192	.1121	39.7	.3176
($\hat{y}$ =		0.90	134.8	74.0	90	0.431	.1128	89.6	.3196
15.6')	2.5	0.05	218.7	-9.9	5	0.024	.1065	5.7	.3017
		0.10	213.4	-4.7	10	0.048	.1054	10.9	.2986
		0.40	182.0	26.7	40	0.192	.1002	42.3	.2839
		0.90	130.5	78.3	90	0.431	.0959	93.9	.2717
	3	0.05	218.1	-9.3	5	0.024	.1039	6.3	.2943
		0.10	212.3	-3.6	10	0.048	.1008	12.0	.2856
		0.40	179.4	29.3	40	0.192	.0900	44.9	.2550
		0.90	126.8	82.0	90	0.431	.0828	97.6	.2346
	4	0	224.0	-15.2	0	0	.1078	0.4	.3054
		0.05	216.6	-7.8	5	0.024	.0982	7.8	.2782
		0.10	209.9	-1.2	10	0.048	.0918	14.4	.2601
		0.40	174.9	33.9	40	0.192	.0739	49.5	.2094
		0.90	121.0	87.7	90	0.431	.0647	103.3	.1833

TABLE BA-8

Storage Equzlization Computed Characteristics

Demand Schedule: Belmont H.S. Typical Day. ($a/\overline{Q_d} = 0.353$)

Specific Speed : $N_s = 2,200$ $N = 1,150$ rpm

Mean Demand : $\overline{Q_d} = 20$ mgd $E_{pd} = 243.3$ ft.

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a
4.00	2	0.025	241.3	2.0	10	0.041	.1130	9.8	.3201
($V/\overline{Q_d}$		0.100	211.4	31.9	40	0.164	.1132	39.7	.3207
=20%)		0.200	171.4	71.9	80	0.329	.1132	79.7	.3207
($\hat{y}$ =	2.5	0.025	240.7	2.5	10	0.041	.1088	10.3	.3082
7.8')		0.100	209.6	33.7	40	0.164	.1017	41.5	.2881
		0.200	168.5	74.7	80	0.329	.0975	82.5	.2762
	3	0.025	239.9	3.4	10	0.041	.1042	11.2	.2952
		0.100	207.6	35.6	40	0.164	.0917	43.4	.2598
		0.200	165.8	77.4	80	0.329	.0851	85.2	.2411
	4	0.025	238.0	5.3	10	0.041	.0951	13.1	.2694
		0.100	204.0	39.2	40	0.164	.0759	47.0	.2150
		0.200	161.4	81.9	80	0.329	.0674	89.7	.1909

TABLE CUS-1(a)

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.468$

Specific Speed : $N_s = 2,200$ $N = 1.750$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 10 mgd; E_{pd} = 268.2 Ft.)										
2	2	0	277.1	-8.9	0	0	.1465	0.4	.3131	
(20%)		0.05	272.1	-3.9	5	0.019	.1467	5.4	.3135	
		0.10	267.4	0.9	10	0.037	.1475	10.2	.3151	
($\hat{y}$ =		0.40	237.5	30.8	40	0.149	.1483	40.1	.3169	
9.3')		0.90	187.7	80.6	90	0.336	.1490	89.9	.3183	
	3	0.05	271.3	-3.0	5	0.019	.1415	6.3	.3024	
		0.10	265.7	2.6	10	0.037	.1379	11.9	.2947	
		0.40	232.8	35.5	40	0.149	.1241	44.8	.2652	
		0.90	179.6	88.6	90	0.336	.1145	97.9	.2447	
	4	0.05	269.7	-1.5	5	0.019	.1357	7.8	.2899	
		0.10	263.2	5.1	10	0.037	.1283	14.4	.2741	
		0.40	227.6	40.6	40	0.149	.1055	50.0	.2254	
		0.90	172.6	95.7	90	0.336	.0923	105.0	.1973	
1	2	0	285.3	-17.1	0	0	.1428	1.5	.3051	0.7'*
(10%)		0.05	280.5	-12.3	5	0.019	.1435	6.4	.3067	0.6'*
		0.10	275.7	-7.4	10	0.037	.1441	11.2	.3080	0.6'*
($\hat{y}$ =		0.40	246.1	22.2	40	0.149	.1460	40.8	.3119	0.3'*
18.6')		0.90	196.3	71.9	90	0.336	.1471	90.5	.3143	
	3	0.05	279.4	-11.2	5	0.019	.1388	7.5	.2965	0.5'*
		0.10	273.5	-5.3	10	0.037	.1353	13.4	.2892	0.4'*
		0.40	240.0	28.3	40	0.149	.1227	46.9	.2622	
		0.90	186.4	81.8	90	0.336	.1136	100.4	.2427	
	4	0.05	277.6	-9.3	5	0.019	.1333	9.3	.2848	0.4'*
		0.10	270.5	-2.2	10	0.037	.1262	16.4	.2696	0.2'*
		0.40	233.8	34.4	40	0.149	.1049	53.1	.2242	
		0.90	178.1	90.1	90	0.336	.0920	108.8	.1966	
($\overline{Q_d}$ = 20 mgd; E_{pd} = 425.8 Ft.)										
4	3	0.10	390.4	35.4	40	0.094	.1301	44.7	.2780	
(20%)	4	0.10	384.2	41.6	40	0.094	.1140	51.0	.2436	
2	3	0.10	398.0	27.8	40	0.094	.1288	46.4	.2752	
(10%)	4	0.10	391.0	34.8	40	0.094	.1134	53.5	.2424	

(*: approximate run)

TABLE CUS-1(b)

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.468$

Specific Speed : $N_s = 2,200$ $N = 1,150$ rpm

V, mg	n	φ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 Ft.)						
4	2	0	252.2	-8.9	0	0	.1463	0.4	.3127	
(20%)		0.010	248.2	-4.9	4	0.016	.1465	4.4	.3129	
		0.025	242.3	0.9	10	0.041	.1470	10.3	.3142	
($\hat{y}$ =		0.10	212.5	30.8	40	0.164	.1482	40.1	.3167	
9.3')		0.20	172.6	70.6	80	0.329	.1488	80.0	.3180	
	3	0.010	247.4	-4.1	4	0.016	.1418	5.2	.3030	
		0.025	240.6	2.6	10	0.041	.1369	12.0	.2925	
		0.10	207.8	35.5	40	0.164	.1227	44.8	.2623	
		0.20	165.3	78.0	80	0.329	.1147	87.3	.2450	
	4	0.010	246.1	-2.8	4	0.016	.1365	6.5	.2917	
		0.025	238.2	5.0	10	0.041	.1270	14.4	.2713	
		0.10	202.8	40.5	40	0.164	.1037	49.8	.2215	
		0.20	158.8	84.4	80	0.329	.0926	93.8	.1979	
2	2	0	260.1	-16.8	0	0	.1415	1.8	.3023	0.9'*
(10%)		0.010	256.3	-13.0	4	0.016	.1423	5.6	.3041	0.8'*
		0.025	250.5	-7.3	10	0.041	.1433	11.4	.3062	0.6'*
($\hat{y}$ =		0.10	221.1	22.2	40	0.164	.1457	40.8	.3113	0.3'*
18.6')		0.20	181.3	62.0	80	0.329	.1467	80.6	.3134	
	3	0.010	255.4	-12.1	4	0.016	.1382	6.5	.2953	0.7'*
		0.025	248.4	-5.1	10	0.041	.1340	13.5	.2863	0.5'*
		0.10	214.9	28.4	40	0.164	.1213	47.0	.2592	
		0.20	172.1	71.2	80	0.329	.1137	89.8	.2430	
	4	0.010	253.9	-10.6	4	0.016	.1334	8.0	.2851	0.5'*
		0.025	245.4	-2.1	10	0.041	.1245	16.6	.2660	0.3'*
		0.10	208.9	34.4	40	0.164	.1031	53.0	.2204	
		0.20	164.3	78.9	80	0.329	.0923	97.6	.1972	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)						
2	3	0.10	150.2	3.0	10	0.065	.1315	12.4	.2811	
(20%)		0.15	144.7	8.6	15	0.098	.1277	17.9	.2729	
	4	0.10	148.0	5.3	10	0.065	.1191	14.6	.2545	
		0.15	141.9	11.3	15	0.098	.1126	20.6	.2405	
1	3	0.10	157.2	-3.9	10	0.065	.1256	14.7	.2685	0.8'*
(10%)		0.15	151.7	1.6	15	0.098	.1234	20.2	.2636	0.6'*
	4	0.10	154.5	-1.3	10	0.065	.1148	17.4	.2453	0.5'*
		0.15	148.2	5.1	15	0.098	.1094	23.7	.2338	0.3'*

(*: approximate run)

TABLE CUS-2(a)

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.468$

Specific Speed : $N_s = 3,000$ $N = 1,450$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 Ft.)										
4 (20%) ($\hat{y}$ = 9.3')	2	0	227.9	-8.8	0	0	.1465	0.5	.3130	
		0.010	223.9	-4.8	4	0.018	.1466	4.5	.3132	
		0.025	218.1	1.0	10	0.046	.1472	10.4	.3145	
		0.10	188.4	30.8	40	0.183	.1484	40.1	.3171	
		0.20	148.5	70.6	80	0.365	.1489	79.9	.3182	
	3	0.010	223.2	-4.0	4	0.018	.1422	5.3	.3038	
		0.025	216.4	2.7	10	0.046	.1377	12.0	.2941	
		0.10	183.5	35.6	40	0.183	.1238	45.0	.2644	
		0.20	140.9	78.2	80	0.365	.1156	87.5	.2470	
	4	0.010	221.9	-2.8	4	0.018	.1372	6.6	.2932	
		0.025	213.9	5.2	10	0.046	.1279	14.5	.2733	
		0.10	178.3	40.8	40	0.183	.1051	50.1	.2247	
		0.20	134.3	84.9	80	0.365	.0939	94.2	.2005	
2 (10%) ($\hat{y}$ = 18.6')	2	0	235.9	-16.8	0	0	.1424	1.9	.3044	0.7'*
		0.010	232.1	-13.0	4	0.018	.1431	5.7	.3058	0.7'*
		0.025	226.3	-7.2	10	0.046	.1439	11.5	.3075	0.6'*
		0.10	196.8	22.3	40	0.183	.1459	41.0	.3117	0.2'*
		0.20	157.1	62.1	80	0.365	.1467	80.7	.3136	
	3	0.010	231.2	-12.0	4	0.018	.1392	6.6	.2974	0.6'*
		0.025	224.2	-5.0	10	0.046	.1350	13.6	.2884	0.5'*
		0.10	190.6	28.5	40	0.183	.1223	47.2	.2614	
		0.20	147.7	71.4	80	0.365	.1145	90.1	.2448	
	4	0.010	229.7	-10.5	4	0.018	.1345	8.1	.2875	0.5'*
		0.025	221.1	-1.9	10	0.046	.1257	16.7	.2686	0.2'*
		0.10	184.5	34.6	40	0.183	.1046	53.3	.2235	
		0.20	139.8	79.3	80	0.365	.0935	98.0	.1997	
($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)										
2 (20%)	3	0.10	135.0	3.1	10	0.072	.1325	12.4	.2832	
		0.15	129.4	8.6	15	0.109	.1287	17.9	.2751	
	4	0.10	132.7	5.3	10	0.072	.1205	14.7	.2575	
		0.15	126.5	11.5	15	0.109	.1139	20.8	.2433	
1 (10%)	3	0.10	142.1	-4.0	10	0.072	.1272	14.6	.2718	0.8'*
		0.15	136.5	1.5	15	0.109	.1247	20.2	.2665	0.6'*
	4	0.10	139.3	-1.3	10	0.072	.1165	17.4	.2489	0.5'*
		0.15	132.9	5.1	15	0.109	.1110	23.8	.2372	0.2'*

(*: approximate runs)

TABLE CUS-2(b)

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.468$

Specific Speed : $N_s = 3,000$ N = 1,450 rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)						
2	2	0	146.6	-8.6	0	0	.1447	0.7	.3091	0.2'*
(20%)		0.05	141.7	-3.7	5	0.036	.1453	5.6	.3106	
		0.10	136.8	1.2	10	0.072	.1458	10.6	.3116	
($\hat{y}$ =		0.40	107.1	30.9	40	0.290	.1475	40.2	.3152	
9.3')		0.90	57.4	80.7	90	0.652	.1487	90.0	.3178	
	3	0.05	140.7	-2.7	5	0.036	.1377	6.7	.2942	
		0.10	135.0	3.1	10	0.072	.1325	12.4	.2832	
		0.40	102.4	35.7	40	0.290	.1176	45.0	.2512	
		0.90	49.7	88.4	90	0.652	.1095	97.7	.2339	
	4	0.05	139.1	-1.1	5	0.036	.1294	8.3	.2765	
		0.10	132.7	5.3	10	0.072	.1205	14.7	.2575	
		0.40	98.1	40.0	40	0.290	.0972	49.3	.2077	
		0.90	44.0	94.0	90	0.652	.0863	103.3	.1845	
1	2	0	153.5	-15.5	0	0	.1340	3.2	.2864	1.7'*
(10%)		0.05	148.9	-10.8	5	0.036	.1363	7.8	.2911	1.4'*
		0.10	144.2	-6.2	10	0.072	.1382	12.5	.2953	1.1'*
($\hat{y}$ =		0.40	115.5	22.5	40	0.290	.1443	41.2	.3084	0.5'*
18.6')		0.90	66.0	72.1	90	0.652	.1464	90.7	.3129	
	3	0.05	147.6	-9.6	5	0.036	.1301	9.1	.2780	1.0'*
		0.10	142.1	-4.0	10	0.072	.1272	14.6	.2718	0.8'*
		0.40	109.1	29.0	40	0.290	.1158	47.6	.2475	
		0.90	56.2	81.9	90	0.652	.1086	100.5	.2320	
	4	0.05	146.0	-7.9	5	0.036	.1236	10.7	.2641	0.8'*
		0.10	139.3	-1.3	10	0.072	.1165	17.4	.2489	0.5'*
		0.40	103.8	34.3	40	0.290	.0964	52.9	.2060	
		0.90	49.1	88.9	90	0.652	.0859	107.6	.1836	
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 160.9')						
4	3	0.10	125.3	35.6	40	0.249	.1197	44.9	.2557	
(20%)	4	0.10	120.7	40.2	40	0.249	.0998	49.5	.2133	
2	3	0.10	132.1	28.8	40	0.249	.1180	47.5	.2522	
(10%)	4	0.10	126.5	34.3	40	0.249	.0991	53.0	.2117	

(*: approximate runs)

Table CUS-3(a)

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.468$

Specific Speed : $N_s = 4,000$ $N = 1.750$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 Ft.)										
4	2	0	200.8	-8.9	0	0	.1474	0.4	.3149	
(20%)		0.010	196.8	-4.9	4	0.021	.1475	4.4	.3152	
		0.025	191.0	0.9	10	0.052	.1481	10.2	.3164	
($\hat{y}$ =		0.10	161.2	30.7	40	0.208	.1487	40.0	.3178	
9.3')		0.20	121.3	70.6	80	0.417	.1491	79.9	.3185	
	3	0.010	196.1	-4.2	4	0.021	.1440	5.1	.3078	
		0.025	189.5	2.4	10	0.052	.1403	11.7	.2997	
		0.10	156.3	35.6	40	0.208	.1272	44.9	.2717	
		0.20	113.5	78.4	80	0.417	.1186	87.7	.2535	
	4	0.010	194.8	-2.9	4	0.021	.1398	6.4	.2986	
		0.025	186.8	5.1	10	0.052	.1316	14.4	.2813	
		0.10	150.6	41.3	40	0.208	.1098	50.6	.2347	
		0.20	105.9	85.9	80	0.417	.0979	95.3	.2091	
2	2	0	209.3	-17.4	0	0	.1449	1.3	.3095	0.5'*
(10%)		0.010	205.3	-13.5	4	0.021	.1451	5.2	.3101	0.4'*
		0.025	199.4	-7.6	10	0.052	.1455	11.1	.3108	0.3'*
($\hat{y}$ =		0.10	169.7	22.2	40	0.208	.1464	40.8	.3128	
18.6')		0.20	130.0	61.9	80	0.417	.1473	80.6	.3148	
	3	0.010	204.5	-12.6	4	0.021	.1418	6.1	.3031	0.4'*
		0.025	197.4	-5.5	10	0.052	.1379	13.2	.2947	0.3'*
		0.10	163.7	28.2	40	0.208	.1258	46.8	.2688	
		0.20	120.5	71.3	80	0.417	.1177	90.0	.2516	
	4	0.010	202.9	-11.0	4	0.021	.1379	7.6	.2946	0.2'*
		0.025	194.2	-2.3	10	0.052	.1298	16.3	.2773	
		0.10	157.1	34.8	40	0.208	.1093	53.5	.2335	
		0.20	111.7	80.2	80	0.417	.0975	98.8	.2083	
($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 Ft.)										
2	3	0.10	118.1	2.8	10	0.083	.1357	12.1	.2899	
(20%)		0.15	112.5	8.4	15	0.124	.1319	17.7	.2819	
	4	0.10	115.7	5.2	10	0.083	.1248	14.5	.2668	
		0.15	109.4	11.5	15	0.124	.1185	20.8	.2532	
1	3	0.10	125.6	-4.7	10	0.083	.1320	14.0	.2820	0.6'*
(10%)		0.15	119.9	1.0	15	0.124	.1291	19.7	.2758	0.4'*
	4	0.10	122.6	-1.7	10	0.083	.1220	16.9	.2606	0.3'*
		0.15	116.0	4.8	15	0.124	.1163	23.5	.2485	

(*: approximate run)

TABLE CUS-3(b)

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.468$

Specific Speed : $N_s = 4,000$ $N = 1,450$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 10 mgd; E_{pd} = 94.1 Ft.)										
2	2	0	102.7*	-8.6*	0	0	.1447*	0.7*	.3092*	0.2'
(20%)		0.05	97.8*	-3.7*	5	0.053	.1453*	5.6*	.3106*	0.2'
		0.10	92.9*	1.2*	10	0.106	.1458*	10.5*	.3116*	0.2'
($\hat{y}$ =		0.40	63.2	30.9	40	0.425	.1475	40.2	.3152	
9.3')		0.90	13.4	80.7	90	0.957	.1487	90.0	.3178	
	3	0.05	96.8	-2.7	5	0.053	.1377	6.6	.2943	
		0.10	91.1	3.0	10	0.106	.1326	12.3	.2834	
		0.40	58.5	35.6	40	0.425	.1177	44.9	.2514	
		0.90	5.7	88.3	90	0.957	.1095	97.7	.2340	
	4	0.05	95.2	-1.1	5	0.053	.1295	8.2	.2766	
		0.10	88.8	5.3	10	0.106	.1206	14.6	.2577	
		0.40	54.1	40.0	40	0.425	.0973	49.3	.2079	
		0.90	-.0	94.1	90	0.957	.0864	103.4	.1846	
1	2	0	109.5*	-15.4*	0	0	.1339*	3.2*	.2861*	1.7'
(10%)		0.05	104.9*	-10.8*	5	0.053	.1364*	7.8*	.2915*	1.4'
		0.10	100.2*	-6.2*	10	0.106	.1383*	12.5*	.2955*	1.1'
($\hat{y}$ =		0.40	71.6*	22.5*	40	0.425	.1444*	41.1*	.3085*	0.5'
18.6')		0.90	22.0	72.1	90	0.957	.1464	90.7	.3129	
	3	0.05	103.7*	-9.6*	5	0.053	.1302*	9.1*	.2782*	1.1'
		0.10	98.1*	-4.0*	10	0.106	.1274*	14.6*	.2723*	0.8'
		0.40	65.1	28.9	40	0.425	.1159	47.6	.2478	
		0.90	12.2	81.8	90	0.957	.1087	100.5	.2322	
	4	0.05	102.0*	-8.0*	5	0.053	.1238*	10.7*	.2646*	0.8'
		0.10	95.4*	-1.3*	10	0.106	.1167*	17.4*	.2494*	0.5'
		0.40	59.8	34.3	40	0.425	.0965	52.9	.2063	
		0.90	5.0	89.1	90	0.957	.0860	107.7	.1837	
($\overline{Q_d}$ = 20 mgd; E_{pd} = 149.3 Ft.)										
4	3	0.10	113.8	35.6	40	0.268	.1239	44.9	.2646	
(20%)	4	0.10	108.5	40.8	40	0.268	.1052	50.1	.2249	
2	3	0.10	120.9	28.4	40	0.268	.1224	47.1	.2616	
(10%)	4	0.10	114.7	34.6	40	0.268	.1047	53.2	.2237	

(*: approximate run)

TABLE CUS-4

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.468$

n = 2.5, only

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
(N_s = 2,200; $\overline{Q_d}$ = 20 mgd; N = 1,150 rpm; E_{pd} = 243.3 Ft.)										
4	2.5	0.05	231.1	12.2	20	0.082	.1388	21.5	.2966	
(20%)		0.10	210.3	33.0	40	0.164	.1346	42.3	.2877	
($\hat{y}$ =		0.15	189.6	53.7	60	0.247	.1318	63.0	.2817	
9.3')		0.25	148.3	94.9	100	0.411	.1283	104.2	.2742	
2	2.5	0.05	239.0	4.2	20	0.082	.1363	22.9	.2912	0.3'*
(10%)		0.10	218.0	25.3	40	0.164	.1325	43.9	.2832	
($\hat{y}$ =		0.15	197.2	46.1	60	0.247	.1301	64.7	.2779	
18.6')		0.25	155.9	87.3	100	0.411	.1271	106.0	.2716	
(N_s = 3,000; $\overline{Q_d}$ = 20 mgd; N = 1,450 rpm; E_{pd} = 219.1 Ft.)										
4	2.5	0.05	206.9	12.2	20	0.091	.1394	21.6	.2979	
(20%)		0.10	186.1	33.1	40	0.183	.1352	42.4	.2889	
($\hat{y}$ =		0.15	165.3	53.8	60	0.274	.1324	63.1	.2828	
9.3')		0.25	124.1	95.0	100	0.456	.1289	104.3	.2754	
2	2.5	0.05	214.8	4.4	20	0.091	.1370	23.0	.2927	0.4'*
(10%)		0.10	193.7	25.4	40	0.183	.1332	44.0	.2846	
($\hat{y}$ =		0.15	173.0	46.2	60	0.274	.1307	64.8	.2793	
18.6')		0.25	131.7	87.4	100	0.456	.1277	106.1	.2729	
(N_s = 4,000; $\overline{Q_d}$ = 20 mgd; N = 1,750 rpm; E_{pd} = 191.9 Ft.)										
4	2.5	0.05	179.9	12.0	20	0.104	.1415	21.3	.3024	
(20%)		0.10	158.9	32.9	40	0.208	.1373	42.3	.2935	
($\hat{y}$ =		0.15	138.2	53.7	60	0.313	.1345	63.0	.2874	
9.3')		0.25	96.9	95.0	100	0.521	.1307	104.3	.2794	
2	2.5	0.05	187.9	4.0	20	0.104	.1392	22.6	.2975	0.2'*
(10%)		0.10	166.9	25.0	40	0.208	.1355	43.6	.2896	
($\hat{y}$ =		0.15	146.0	45.8	60	0.313	.1329	64.5	.2840	
18.6')		0.25	104.7	87.2	100	0.521	.1298	105.9	.2774	

(*: approximate run)

TABLE CUA-1

Storage Equalization Computed Characteristics

Demand Schedule: Champaign-Urbana Peak Day ($a/\overline{Q_d}$ = 0.468)

Specific Speed : N_s = 2,200 N = 1,150

V, mg	n	Φ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 Ft.)										
4	2	0	251.7	-8.5	0	0	.1496	-0.4	.3197	0.2'*
(20%)		0.01	247.7	-4.5	4	0.016	.1497	3.6	.3199	0.2'*
		0.025	241.7	1.6	10	0.041	.1498	9.6	.3201	0.2'*
($\hat{y}$ =		0.10	211.6	31.6	40	0.164	.1499	39.7	.3203	
8.0')		0.20	171.6	71.7	80	0.329	.1499	79.7	.3202	
	3	0.01	246.5	-3.2	4	0.016	.1428	4.8	.3052	0.2'*
		0.025	239.0	4.2	10	0.041	.1353	12.3	.2891	
		0.10	205.0	38.3	40	0.164	.1178	46.3	.2516	
		0.20	161.7	81.6	80	0.329	.1089	89.6	.2326	
	4	0.01	244.0	-0.7	4	0.016	.1324	7.3	.2829	
		0.025	235.0	8.3	10	0.041	.1189	16.3	.2540	
		0.10	198.4	44.9	40	0.164	.0938	52.9	.2004	
		0.20	153.6	89.7	80	0.329	.0833	97.7	.1781	
2	2	0	260.2	-16.9	0	0	.1471	-0.8	.3144	1.3'*
(10%)		0.01	256.2	-13.0	4	0.016	.1477	3.1	.3155	1.2'*
		0.025	250.3	-7.1	10	0.041	.1482	9.0	.3167	1.1'*
($\hat{y}$ =		0.10	220.4	22.9	40	0.164	.1491	38.9	.3186	0.7'*
16.0')		0.20	180.3	63.0	80	0.329	.1498	79.0	.3201	0.4'*
	3	0.01	254.7	-11.4	4	0.016	.1414	4.6	.3022	1.0'*
		0.025	246.9	-3.6	10	0.041	.1348	12.4	.2880	0.8'*
		0.10	211.5	31.8	40	0.164	.1171	47.8	.2502	0.2'*
		0.20	167.4	75.9	80	0.329	.1084	91.9	.2316	
	4	0.01	251.7	-8.4	4	0.016	.1321	7.6	.2822	0.8'*
		0.025	241.7	1.6	10	0.041	.1188	17.6	.2539	0.4'*
		0.10	203.3	40.0	40	0.164	.0937	56.0	.2002	
		0.20	157.9	85.3	80	0.329	.0833	101.4	.1779	
($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)										
2	3	0.10	149.0	4.3	10	0.065	.1297	12.3	.2772	0.2'*
(20%)		0.15	143.1	10.2	15	0.098	.1243	18.2	.2657	0.2'*
($\hat{y}$ =	4	0.10	145.3	7.9	10	0.065	.1105	15.9	.2361	
8.0')		0.15	139.0	14.3	15	0.098	.1031	22.3	.2203	
1	3	0.10	156.3	-3.1	10	0.065	.1276	13.0	.2726	1.1'*
(10%)		0.15	150.3	3.0	15	0.098	.1235	19.0	.2638	0.9'*
($\hat{y}$ =	4	0.10	151.7	1.5	10	0.065	.1100	17.6	.2350	0.6'*
16.0')		0.15	144.8	8.5	15	0.098	.1028	24.5	.2198	0.3'*

(*: approximate run).

(Continued)

TABLE CUA-1 (Continued)

Storage Equalization Computed Characteristics

Demand Schedule: Champaign-Urbana Peak Day ($a/\overline{Q_d} = 0.468$)

Specific Speed : $N_s = 2,200$ $N = 1,750$

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y - \hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 268.2 ft.)						
2	3	0.40	229.2	38.4	40	0.149	.1190	46.4	.2543	
(20%)	4	0.40	223.0	45.2	40	0.149	.0956	53.2	.2042	
1	3	0.40	236.4	31.8	40	0.149	.1184	47.9	.2531	0.2'*
(10%)	4	0.40	228.0	40.2	40	0.149	.0954	56.3	.2038	
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 425.8 ft.)						
4	3	0.10	387.1	38.7	40	0.094	.1255	46.7	.2682	
(20%)	4	0.10	378.4	47.4	40	0.094	.1039	55.4	.2221	
2	3	0.10	393.8	32.0	40	0.094	.1250	48.0	.2672	
(10%)	4	0.10	383.8	42.0	40	0.094	.1036	58.1	.2213	

(*: approximate run).

TABLE CUA-2(a)

Storage Equalization Computed Characteristics

Demand Schedule: Champaign-Urbana Peak Day ($a/\overline{Q_d}$ = 0.468)

Specific Speed : N_s = 3,000 N = 1,450 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 Ft.)						
4 (20%)	2	0	227.5	-8.3	0	0	.1497	-0.3	.3199	0.3'*
		0.01	223.5	-4.3	4	0.018	.1498	3.7	.3200	0.2'*
($\hat{y}$ = 8.0')		0.025	217.5	1.7	10	0.046	.1499	9.7	.3202	0.2'*
		0.10	187.4	31.7	40	0.183	.1499	39.7	.3203	
		0.20	147.4	71.7	80	0.365	.1499	79.7	.3204	
	3	0.01	222.2	-3.1	4	0.018	.1433	4.9	.3062	
		0.025	214.8	4.4	10	0.046	.1360	12.4	.2906	
		0.10	180.6	38.5	40	0.183	.1187	46.5	.2536	
		0.20	137.3	81.8	80	0.365	.1098	89.8	.2347	
	4	0.01	219.7	-0.5	4	0.018	.1332	7.5	.2846	
		0.025	210.7	8.5	10	0.046	.1203	16.5	.2570	
		0.10	174.1	45.0	40	0.183	.0956	53.1	.2042	
		0.20	129.3	89.9	80	0.365	.0849	97.9	.1815	
2 (10%)	2	0	235.9	-16.7	0	0	.1476	-0.7	.3154	1.2'*
		0.01	231.9	-12.8	4	0.018	.1480	3.2	.3162	1.1'*
($\hat{y}$ = 16.0')		0.025	226.0	-6.9	10	0.046	.1484	9.2	.3171	1.0'*
		0.10	196.1	23.0	40	0.183	.1492	39.1	.3188	0.7'*
		0.20	156.0	63.1	80	0.365	.1498	79.1	.3201	0.4'*
	3	0.01	230.4	-11.3	4	0.018	.1421	4.8	.3036	1.0'*
		0.025	222.6	-3.5	10	0.046	.1355	12.6	.2896	0.7'*
		0.10	187.1	32.0	40	0.183	.1180	48.1	.2522	0.2'*
		0.20	143.1	76.1	80	0.365	.1094	92.1	.2338	
	4	0.01	227.4	-8.2	4	0.018	.1330	7.8	.2842	0.7'*
		0.025	217.4	1.8	10	0.046	.1201	17.8	.2566	0.3'*
		0.10	179.1	40.1	40	0.183	.0954	56.1	.2038	
		0.20	133.5	85.6	80	0.365	.0846	101.7	.1808	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)						
2 (20%)	3	0.10	133.7	4.4	10	0.072	.1305	12.4	.2788	0.2'*
		0.15	127.7	10.3	15	0.109	.1253	18.3	.2676	
($\hat{y}$ = 8.0')	4	0.10	130.0	8.0	10	0.072	.1121	16.0	.2395	
		0.15	123.7	14.3	15	0.109	.1049	22.3	.2241	
1 (10%)	3	0.10	141.1	-3.1	10	0.072	.1290	13.0	.2756	1.1'*
		0.15	135.0	3.0	15	0.109	.1247	19.1	.2664	0.8'*
($\hat{y}$ = 16.0')	4	0.10	136.5	1.6	10	0.072	.1118	17.6	.2388	0.6'*
		0.15	129.6	8.4	15	0.109	.1047	24.5	.2238	0.3'*

(*: approximate run).

TABLE CUA-2(b)

Storage Equalization Computed Characteristics

Demand Schedule: Champaign-Urbana Peak Day ($a/\overline{Q_d}$ = 0.468)

Specific Speed : N_s = 3,000 N = (See Table)

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 10 mgd; N = 1,450 rpm; E_{pd} = 138.0 Ft.)										
2	2	0	146.4	-8.4	0	0	.1487	-0.4	.3177	0.4'*
(20%)		0.05	141.5	-3.4	5	0.036	.1489	4.6	.3181	0.4'*
		0.10	136.5	1.6	10	0.072	.1491	9.6	.3186	0.4'*
($\hat{y}$ =		0.40	106.4	31.6	40	0.290	.1499	39.6	.3202	
8.0')		0.90	56.3	81.7	90	0.652	.1498	89.7	.3202	
	3	0.05	139.8	-1.8	5	0.036	.1378	6.2	.2945	0.2'*
		0.10	133.7	4.4	10	0.072	.1305	12.4	.2788	0.2'*
		0.40	99.9	38.1	40	0.290	.1125	46.1	.2404	
		0.90	46.4	91.7	90	0.652	.1038	99.7	.2218	
	4	0.05	137.1	1.0	5	0.036	.1237	9.0	.2642	
		0.10	130.0	8.0	10	0.072	.1121	16.0	.2395	
		0.40	94.6	43.4	40	0.290	.0881	51.4	.1883	
		0.90	39.5	98.5	90	0.652	.0782	106.5	.1671	
1	2	0	154.5	-16.5	0	0	.1427	-0.4	.3049	2.3'*
(10%)		0.05	149.6	-11.5	5	0.036	.1440	4.5	.3078	1.9'*
		0.10	144.6	-6.6	10	0.072	.1450	9.4	.3099	1.6'*
($\hat{y}$ =		0.40	115.1	22.9	40	0.290	.1486	39.0	.3176	0.9'*
16.0')		0.90	65.1	73.0	90	0.652	.1497	89.0	.3198	0.5'*
	3	0.05	147.4	-9.4	5	0.036	.1343	6.7	.2871	1.4'*
		0.10	141.1	-3.1	10	0.072	.1290	13.0	.2756	1.1'*
		0.40	106.2	31.8	40	0.290	.1122	47.9	.2397	0.2'*
		0.90	51.8	86.3	90	0.652	.1033	102.3	.2207	
	4	0.05	144.2	-6.2	5	0.036	.1223	9.9	.2613	1.0'*
		0.10	136.5	1.6	10	0.072	.1118	17.6	.2388	0.6'*
		0.40	99.3	38.8	40	0.290	.0881	54.8	.1882	
		0.90	43.6	94.5	90	0.652	.0780	110.5	.1667	
($\overline{Q_d}$ = 20 mgd; N = 1,150 rpm; E_{pd} = 160.9 Ft.)										
4	3	0.10	122.6	38.3	40	0.249	.1145	46.3	.2446	
(20%) ($\hat{y}$ = 8.0')	4	0.10	117.0	43.9	40	0.249	.0904	51.9	.1932	
2 (10%)	3	0.10	129.0	31.9	40	0.249	.1141	47.9	.2437	0.2'*
($\hat{y}$ = 16.0')	4	0.10	121.7	39.1	40	0.249	.0904	55.2	.1932	

(*: approximate runs).

TABLE CUA-3(a)

Storage Equalization Computed Characteristics

Demand Schedule: Champaign-Urbana Peak Day ($a/\overline{Q_d}$ = 0.468)

Specific Speed : N_s = 4,000 N = 1,750 rpm

V, mg	n	φ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 Ft.)						
4	2	0	200.2	-8.3	0	0	.1499	-0.3	.3203	
(20%)		0.010	196.2	-4.3	4	0.021	.1499	3.7	.3203	
		0.025	190.2	1.7	10	0.052	.1499	9.7	.3203	
($\hat{y}$ =		0.20	120.2	71.6	80	0.417	.1500	79.7	.3205	
8.0')	3	0.010	195.0	-3.1	4	0.021	.1447	4.9	.3091	
		0.025	187.6	4.3	10	0.052	.1386	12.3	.2962	
		0.20	109.6	82.3	80	0.417	.1129	90.3	.2413	
	4	0.010	192.4	-0.5	4	0.021	.1362	7.5	.2910	
		0.025	183.2	8.7	10	0.052	.1245	16.7	.2661	
		0.20	100.1	91.8	80	0.417	.0883	99.8	.1888	
2	2	0	208.8*	-16.9*	0	0	.1488*	-0.9*	.3179*	0.9'
(10%)		0.010	204.8*	-12.9*	4	0.021	.1488*	3.1*	.3181*	0.8'
		0.025	198.8*	-6.9*	10	0.052	.1489*	9.1*	.3182*	0.7'
($\hat{y}$ =		0.20	128.7*	63.1*	80	0.417	.1499*	79.2*	.3203*	0.3'
16.0')	3	0.010	203.4*	-11.5*	4	0.021	.1439*	4.6*	.3075*	0.8'
		0.025	195.6*	-3.7*	10	0.052	.1381*	12.3*	.2951*	0.6'
		0.20	115.5	76.4	80	0.417	.1126	92.4	.2406	
	4	0.010	200.3*	-8.4*	4	0.021	.1361*	7.6*	.2907*	0.5'
		0.025	190.0*	1.9*	10	0.052	.1241*	17.9*	.2651*	0.2'
		0.20	104.5	87.4	80	0.417	.0881	103.3	.1883	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 Ft.)						
2	3	0.10	116.5	4.3	10	0.083	.1337	12.4	.2858	
(20%)		0.15	110.6	10.3	15	0.124	.1288	18.3	.2753	
	4	0.10	112.6	8.2	10	0.083	.1165	16.2	.2490	
		0.15	106.1	14.8	15	0.124	.1094	22.8	.2337	
1	3	0.10	124.3*	-3.4*	10	0.083	.1330*	12.7*	.2842*	0.9'
(10%)		0.15	118.1*	2.8*	15	0.124	.1286*	18.9*	.2747*	0.7'
	4	0.10	119.2*	1.7*	10	0.083	.1165*	17.7*	.2490*	0.4'
		0.15	112.1*	8.8*	15	0.124	.1093*	24.8*	.2335*	0.2'
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.0 ft.; N = 1,750 rpm)						
4	3	0.10	153.3	38.6	40	0.208	.1223	46.6	.2614	
(20%)	4	0.10	145.5	46.4	40	0.208	.0998	54.4	.2133	
2	3	0.10	159.8	32.0	40	0.208	.1218	48.1	.2602	
(10%)	4	0.10	150.7	41.1	40	0.208	.0995	57.2	.2127	

(*: approximate run)

TABLE CUA-3(b)

Storage Equalization Computed Characteristics

Demand Schedule: Champaign-Urbana Peak Day ($a/\overline{Q_d}$ = 0.468)

Specific Speed : N_s = 4,000 N = 1,450 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 10 mgd; E_{pd} = 94.1 Ft.)										
2	2	0	102.5	-8.4	0	0	.1487	-0.4	.3178	0.4'*
(20%)		0.05	97.5	-3.4	5	0.053	.1489	4.6	.3182	0.4'*
		0.10	92.5	1.5	10	0.106	.1492	9.6	.3188	0.3'*
($\hat{y}$ =		0.40	62.5	31.6	40	0.425	.1499	39.6	.3202	0.2'*
8.0')		0.90	12.4	81.7	90	0.957	.1499	89.7	.3202	
	3	0.05	95.9	-1.8	5	0.053	.1379	6.2	.2947	0.3'*
		0.10	89.7	4.4	10	0.106	.1306	12.4	.2790	0.2'*
		0.40	56.0	38.1	40	0.425	.1126	46.1	.2405	
		0.90	2.3	91.7	90	0.957	.1038	99.7	.2217	
	4	0.05	93.1	0.9	5	0.053	.1238	9.0	.2645	
		0.10	86.0	8.0	10	0.106	.1121	16.0	.2396	
		0.40	50.6	43.5	40	0.425	.0881	51.5	.1883	
		0.90	-4.5	98.6	90	0.957	.0782	106.6	.1671	
1	2	0	110.5	-16.4	0	0	.1426	-0.4	.3046	2.4'*
(10%)		0.05	105.5	-11.5	5	0.053	.1440	4.5	.3076	1.9'*
		0.10	100.7	-6.6	10	0.106	.1451	9.4	.3100	1.6'*
($\hat{y}$ =		0.40	71.2	22.9	40	0.425	.1487	38.9	.3177	0.9'*
16.0')		0.90	21.1	73.0	90	0.957	.1497	89.0	.3198	0.5'*
	3	0.05	103.5	-9.4	5	0.053	.1344	6.7	.2872	1.5'*
		0.10	97.2	-3.1	10	0.106	.1291	13.0	.2758	1.1'*
		0.40	62.2	31.8	40	0.425	.1122	47.9	.2398	0.2'*
		0.90	7.8	86.3	90	0.957	.1033	102.3	.2207	
	4	0.05	100.2	-6.1	5	0.053	.1224	9.9	.2614	1.0'*
		0.10	92.5	1.6	10	0.106	.1118	17.6	.2388	0.6'*
		0.40	55.2	38.8	40	0.425	.0880	54.9	.1880	
		0.90	-0.6	94.6	90	0.957	.0779	110.6	.1666	
($\overline{Q_d}$ = 20 mgd; E_{pd} = 149.3 Ft.)										
4	3	0.10	110.9	38.5	40	0.268	.1188	46.5	.2538	
(20%)	4	0.10	104.2	45.2	40	0.268	.0955	53.2	.2041	
2	3	0.10	117.4	32.0	40	0.268	.1181	48.0	.2524	0.2'*
(10%)	4	0.10	109.1	40.2	40	0.268	.0953	56.2	.2036	

(*: approximate runs)

TABLE TNHS-1

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.642$

Specific Speed : $N_s = 2,200$ $N = 1,150$ rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 Ft.)						
8	2	0	249.4	-6.2	0	0	.2033	0.2	.3167	
(40%)		0.010	245.5	-2.2	4	0.016	.2034	4.2	.3169	
		0.025	239.8	3.5	10	0.041	.2045	9.9	.3185	
($\hat{y}$ =		0.10	209.9	33.3	40	0.164	.2049	39.7	.3192	
6.4')		0.20	170.0	73.2	80	0.329	.2050	79.6	.3194	
	3	0.010	244.1	-0.9	4	0.016	.1957	5.5	.3049	
		0.025	236.9	6.4	10	0.041	.1880	12.8	.2928	
		0.10	201.9	41.4	40	0.164	.1661	47.7	.2587	
		0.20	157.3	85.9	80	0.329	.1544	92.3	.2405	
	4	0.010	241.7	1.6	4	0.016	.1856	8.0	.2892	
		0.025	232.0	11.2	10	0.041	.1695	17.6	.2640	
		0.10	192.9	50.4	40	0.164	.1368	56.8	.2131	
		0.20	145.6	97.6	80	0.329	.1221	104.0	.1901	
4	2	0	255.3	-12.1	0	0	.2006	0.7	.3125	
(20%)		0.010	251.4	-8.1	4	0.016	.2007	4.7	.3127	
		0.025	245.4	-2.1	10	0.041	.2010	10.7	.3132	
($\hat{y}$ =		0.10	215.8	27.5	40	0.164	.2030	40.2	.3163	
12.8')		0.20	176.1	67.2	80	0.329	.2040	80.0	.3177	
	3	0.010	249.8	-6.5	4	0.016	.1934	6.2	.3012	
		0.025	242.2	1.0	10	0.041	.1857	13.8	.2893	
		0.10	206.7	36.5	40	0.164	.1650	49.3	.2570	
		0.20	161.8	81.5	80	0.329	.1537	94.3	.2394	
	4	0.010	246.8	-3.6	4	0.016	.1834	9.2	.2857	
		0.025	237.0	6.3	10	0.041	.1686	19.1	.2626	
		0.10	196.8	46.5	40	0.164	.1366	59.2	.2128	
		0.20	149.0	94.3	80	0.329	.1218	107.1	.1897	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)						
4	3	0.10	146.7	6.5	10	0.065	.1808	12.9	.2816	
(40%)		0.15	140.8	12.5	15	0.098	.1745	18.9	.2718	
	4	0.10	142.6	10.6	10	0.065	.1589	17.0	.2475	
		0.15	135.9	17.3	15	0.098	.1494	23.7	.2327	
2	3	0.10	151.7	1.5	10	0.065	.1782	14.3	.2775	
(20%)		0.15	145.7	7.5	15	0.098	.1725	20.3	.2687	
	4	0.10	147.2	6.1	10	0.065	.1577	18.8	.2457	
		0.15	140.2	13.0	15	0.098	.1486	25.8	.2315	

TABLE TNHS-2

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.642$

Specific Speed : $N_s = 3,000$ $N = 1,150$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 20 mgd; E_{pd} = 160.9 Ft.)										
8 (40%)	2	0	166.9	-6.0	0	0	.2026	0.4	.3155	
		0.010	162.9	-2.1	4	0.025	.2028	4.3	.3160	
		0.025	157.2	3.7	10	0.062	.2040	10.1	.3177	
($\hat{y}$ = 6.4')		0.10	127.4	33.5	40	0.249	.2047	39.8	.3189	
		0.20	87.6	73.3	80	0.497	.2050	79.7	.3194	
	3	0.010	161.6	-0.7	4	0.025	.1934	5.7	.3013	
		0.025	154.3	6.6	10	0.062	.1845	13.0	.2874	
		0.10	119.6	41.2	40	0.249	.1620	47.6	.2523	
		0.20	75.4	85.5	80	0.497	.1510	91.9	.2353	
	4	0.010	159.2	1.7	4	0.025	.1817	8.1	.2831	
		0.025	149.8	11.1	10	0.062	.1642	17.5	.2558	
		0.10	111.8	49.1	40	0.249	.1322	55.5	.2059	
		0.20	65.2	95.7	80	0.497	.1186	102.1	.1848	
4 (20%)	2	0	172.6*	-11.7*	0	0	.1995*	1.0*	.3108*	0.2'
		0.010	168.7*	-7.8*	4	0.025	.2000*	5.9*	.3115*	0.2'
		0.025	162.8	-1.9	10	0.062	.2004	10.9	.3122	
($\hat{y}$ = 12.8')		0.10	133.3	27.6	40	0.249	.2026	40.4	.3156	
		0.20	93.5	67.4	80	0.497	.2037	80.1	.3173	
	3	0.010	167.1	-6.2	4	0.025	.1910	6.6	.2975	
		0.025	159.4	1.4	10	0.062	.1822	14.2	.2837	
		0.10	124.3	36.6	40	0.249	.1608	49.3	.2504	
		0.20	79.7	81.1	80	0.497	.1503	93.9	.2341	
	4	0.010	164.1	-3.2	4	0.025	.1792	9.6	.2792	
		0.025	154.6	6.3	10	0.062	.1635	19.0	.2547	
		0.10	115.6	45.3	40	0.249	.1320	58.1	.2057	
		0.20	68.4	92.5	80	0.497	.1183	105.2	.1843	
($\overline{Q_d}$ = 10 mgd; E_{pd} = 101.3 Ft.)										
4 (40%)	3	0.10	94.7	6.7	10	0.099	.1766	13.1	.2750	
		0.15	88.8	12.6	15	0.148	.1700	19.0	.2649	
	4	0.10	91.0	10.3	10	0.099	.1539	16.7	.2397	
		0.15	84.5	16.8	15	0.148	.1442	23.2	.2247	
2 (20%)	3	0.10	99.5	1.8	10	0.099	.1736	14.6	.2705	
		0.15	93.6	7.8	15	0.148	.1680	20.6	.2617	
	4	0.10	95.4	6.0	10	0.099	.1521	18.7	.2370	
		0.15	88.7	12.6	15	0.148	.1434	25.4	.2233	

(*: approximate run)

TABLE TNHS-3

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/Q_d = 0.642$

Specific Speed : $N_s = 4,000$ $N = 1,750$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 Ft.)						
8	2	0	198.1	-6.2	0	0	.2039	0.2	.3176	
(40%)		0.010	194.1	-2.2	4	0.021	.2039	4.2	.3176	
		0.025	188.4	3.4	10	0.052	.2048	9.8	.3190	
($\hat{y}$ =		0.10	158.5	33.3	40	0.208	.2049	39.7	.3192	
6.4')		0.20	118.7	73.2	80	0.417	.2051	79.6	.3194	
	3	0.010	192.8	-0.9	4	0.021	.1981	5.5	.3086	
		0.025	185.5	6.4	10	0.052	.1920	12.8	.2990	
		0.10	149.9	42.0	40	0.208	.1720	48.3	.2680	
		0.20	104.9	87.0	80	0.417	.1599	93.4	.2491	
	4	0.010	190.2	1.7	4	0.021	.1903	8.1	.2964	
		0.025	180.0	11.9	10	0.052	.1763	18.2	.2746	
		0.10	139.3	52.6	40	0.208	.1450	59.0	.2258	
		0.20	90.9	101.0	80	0.417	.1293	107.3	.2014	
4	2	0	204.0	-12.1	0	0	.2021	0.7	.3147	
(20%)		0.010	200.0	-8.1	4	0.021	.2023	4.6	.3151	
		0.025	194.1	-2.2	10	0.052	.2025	10.6	.3154	
($\hat{y}$ =		0.10	164.5	27.4	40	0.208	.2037	40.2	.3173	
12.8')		0.20	124.7	67.2	80	0.417	.2042	80.0	.3181	
	3	0.010	198.6	-6.7	4	0.021	.1966	6.1	.3063	
		0.025	191.0	0.9	10	0.052	.1904	13.7	.2966	
		0.10	154.9	37.0	40	0.208	.1711	49.8	.2665	
		0.20	109.4	82.5	80	0.417	.1593	95.3	.2481	
	4	0.010	195.5	-3.6	4	0.021	.1882	9.2	.2931	
		0.025	185.2	6.7	10	0.052	.1751	19.5	.2728	
		0.10	143.4	48.5	40	0.208	.1446	61.3	.2252	
		0.20	94.4	97.5	80	0.417	.1289	110.3	.2008	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 Ft.)						
4	3	0.10	114.4	6.5	10	0.083	.1862	12.9	.2900	
(40%)		0.15	108.3	12.5	15	0.124	.1803	18.9	.2808	
	4	0.10	109.7	11.1	10	0.083	.1666	17.5	.2595	
		0.15	102.7	18.2	15	0.124	.1574	24.6	.2452	
2	3	0.10	119.6	1.3	10	0.083	.1839	14.1	.2864	
(20%)		0.15	113.5	7.4	15	0.124	.1785	20.2	.2780	
	4	0.10	114.5	6.4	10	0.083	.1657	19.2	.2581	
		0.15	107.2	13.7	15	0.124	.1569	26.5	.2444	

TABLE TNHS-4

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.642$

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($N_s = 4,000$; $\overline{Q_d} = 20$ mgd; N = 1,750 rpm; $E_{pd} = 191.9$ Ft.)										
8	2.5	0.05	176.4	15.5	20	0.104	.1944	21.9	.3027	
(40%)		0.10	154.8	37.0	40	0.208	.1880	43.4	.2928	
($\hat{y}$ =		0.15	133.4	58.5	60	0.313	.1836	64.8	.2860	
6.4')		0.25	91.0	100.9	100	0.521	.1780	107.3	.2773	
4	2.5	0.05	182.0	9.9	20	0.104	.1929	22.7	.3004	
(20%)		0.10	160.2	31.7	40	0.208	.1868	44.4	.2910	
($\hat{y}$ =		0.15	138.7	53.1	60	0.313	.1827	65.9	.2846	
12.8')		0.25	96.1	95.8	100	0.521	.1774	108.6	.2763	
($N_s = 3,000$; $\overline{Q_d} = 20$ mgd; N = 1,450 rpm; $E_{pd} = 219.1$ Ft.)										
8	2.5	0.05	203.5	15.6	20	0.091	.1918	22.0	.2988	
(40%)		0.10	182.0	37.1	40	0.183	.1851	43.5	.2883	
($\hat{y}$ =		0.15	160.7	58.4	60	0.274	.1807	64.8	.2815	
6.4')		0.25	118.4	100.8	100	0.456	.1754	107.2	.2732	
4	2.5	0.05	208.9	10.2	20	0.091	.1900	23.0	.2959	
(20%)		0.10	187.3	31.8	40	0.183	.1838	44.6	.2863	
($\hat{y}$ =		0.15	165.9	53.2	60	0.274	.1797	66.0	.2799	
12.8')		0.25	123.4	95.7	100	0.456	.1747	108.5	.2720	
($N_s = 2,200$; $\overline{Q_d} = 20$ mgd; N = 1,150 rpm; $E_pd = 243.3$ Ft.)										
8	2.5	0.05	227.7	15.6	20	0.082	.1912	21.9	.2979	
(40%)		0.10	206.2	37.0	40	0.164	.1843	43.4	.2871	
($\hat{y}$ =		0.15	185.0	58.3	60	0.247	.1799	64.7	.2803	
6.4')		0.25	142.7	100.6	100	0.411	.1746	107.0	.2720	
4	2.5	0.05	233.2	10.0	20	0.082	.1892	22.8	.2948	
(20%)		0.10	211.6	31.7	40	0.164	.1830	44.4	.2850	
($\hat{y}$ =		0.15	190.2	53.1	60	0.247	.1788	65.9	.2785	
12.8')		0.25	147.8	95.5	100	0.411	.1739	108.3	.2709	

TABLE NHA-1

Storage Equalization Computed Characteristics

Demand Schedule: North High Peak Day ($a/\overline{Q_d}$ = 0.642)

Specific Speed : N_s = 2,200   N = 1,150 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 Ft.)						
8	2	0	247.9	-4.6	0	0	.2057	-0.1	.3204	
(40%)		0.010	243.9	-0.6	4	0.016	.2056	3.9	.3202	
		0.025	237.9	5.4	10	0.041	.2056	9.9	.3203	
($\hat{y}$ =		0.10	208.0	35.2	40	0.164	.2057	39.7	.3204	
4.5')		0.20	168.2	75.1	80	0.329	.2057	79.6	.3204	
	3	0.010	242.2	1.1	4	0.016	.1964	5.6	.3058	
		0.025	234.1	9.1	10	0.041	.1862	13.6	.2901	
		0.10	197.7	45.6	40	0.164	.1625	50.1	.2531	
		0.20	151.8	91.5	80	0.329	.1506	96.0	.2345	
	4	0.010	238.2	5.1	4	0.016	.1811	9.6	.2821	
		0.025	227.6	15.7	10	0.041	.1629	20.2	.2538	
		0.10	186.1	57.1	40	0.164	.1305	61.6	.2035	
		0.20	136.9	106.4	80	0.329	.1169	110.8	.1821	
4	2	0	252.8	-9.5	0	0	.2060	-0.5	.3209	0.6'*
(20%)		0.010	248.8	-5.5	4	0.016	.2061	3.5	.3210	0.6'*
		0.025	242.8	0.5	10	0.041	.2061	9.5	.3210	0.5'*
($\hat{y}$ =		0.10	212.7	30.6	40	0.164	.2059	39.6	.3207	0.3'*
9.0')		0.20	172.6	70.7	80	0.329	.2055	79.7	.3201	0.2'*
	3	0.010	246.5	-3.3	4	0.016	.1961	5.7	.3055	0.3'*
		0.025	237.9	5.3	10	0.041	.1855	14.3	.2889	
		0.10	200.9	42.4	40	0.164	.1622	51.4	.2526	
		0.20	154.6	88.7	80	0.329	.1503	97.7	.2341	
	4	0.010	241.7	1.6	4	0.016	.1798	10.6	.2801	
		0.025	230.7	12.6	10	0.041	.1624	21.6	.2529	
		0.10	188.5	54.8	40	0.164	.1303	63.7	.2030	
		0.20	138.8	104.5	80	0.329	.1166	113.5	.1816	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)						
4	3	0.10	144.2	9.1	10	0.065	.1790	13.6	.2788	
(40%)		0.15	137.9	15.3	15	0.098	.1720	19.8	.2679	
	4	0.10	138.8	14.4	10	0.065	.1522	18.9	.2371	
		0.15	131.6	21.6	15	0.098	.1424	26.1	.2218	
2	3	0.10	148.0	5.3	10	0.065	.1781	14.3	.2774	0.3'*
(20%)		0.15	141.4	11.9	15	0.098	.1707	20.9	.2660	
	4	0.10	141.7	11.6	10	0.065	.1517	20.5	.2363	
		0.15	134.4	18.9	15	0.098	.1422	27.9	.2215	

(*: approximate run)

TABLE NHA-2(a)

Storage Equalization Computed Characteristics

Demand Schedule: North High Peak Day ($a/\overline{Q_d}$ = 0.642)

Specific Speed : N_s = 3,000 N = 1,450 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 Ft.)						
8	2	0	223.7	-4.6	0	0	.2056	-0.1	.3202	
(40%)		0.010	219.7	-0.6	4	0.018	.2055	3.9	.3200	
		0.025	213.8	5.4	10	0.046	.2057	9.9	.3204	
($\hat{y}$ =		0.10	183.9	35.2	40	0.183	.2058	39.7	.3206	
4.5')		0.20	144.0	75.1	80	0.365	.2057	79.6	.3204	
	3	0.010	218.0	1.2	4	0.018	.1967	5.7	.3065	
		0.025	209.9	9.3	10	0.046	.1871	13.8	.2914	
		0.10	173.3	45.9	40	0.183	.1640	50.4	.2554	
		0.20	127.4	91.7	80	0.365	.1521	96.2	.2369	
	4	0.010	213.8	5.3	4	0.018	.1822	9.8	.2838	
		0.025	203.1	16.0	10	0.046	.1648	20.5	.2567	
		0.10	161.4	57.7	40	0.183	.1330	62.2	.2072	
		0.20	111.7	107.5	80	0.365	.1190	111.9	.1864	
4	2	0	228.5	-9.3	0	0	.2060	-0.3	.3209	0.6'*
(20%)		0.010	224.5	-5.3	4	0.018	.2061	3.6	.3210	0.5'*
		0.025	218.5	0.7	10	0.046	.2061	9.6	.3210	0.5'*
($\hat{y}$ =		0.10	188.5	30.7	40	0.183	.2058	39.6	.3206	0.3'*
9.0')		0.20	148.4	70.8	80	0.365	.2055	79.7	.3201	0.2'*
	3	0.010	222.3	-3.1	4	0.018	.1967	5.9	.3064	0.3'*
		0.025	213.6	5.5	10	0.046	.1864	14.5	.2904	
		0.10	176.4	42.7	40	0.183	.1636	51.7	.2548	
		0.20	130.2	89.0	80	0.365	.1517	97.9	.2363	
	4	0.010	217.4	1.8	4	0.018	.1812	10.8	.2822	
		0.025	206.2	12.9	10	0.046	.1641	21.9	.2557	
		0.10	163.7	55.4	40	0.183	.1327	64.4	.2067	
		0.20	113.6	105.5	80	0.365	.1187	114.5	.1849	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)						
4	3	0.10	128.9	9.2	10	0.072	.1803	13.7	.2808	
(40%)		0.15	122.6	15.4	15	0.109	.1734	19.9	.2701	
	4	0.10	123.4	14.6	10	0.072	.1545	19.1	.2406	
		0.15	116.4	21.7	15	0.109	.1453	26.2	.2264	
2	3	0.10	132.6	5.4	10	0.072	.1793	14.4	.2792	0.2'*
(20%)		0.15	126.0	12.0	15	0.109	.1721	21.0	.2680	
	4	0.10	126.3	11.7	10	0.072	.1536	20.7	.2393	
		0.15	119.0	19.0	15	0.109	.1445	28.0	.2251	

(*: approximate run)

TABLE NHA-2(b)

Storage Equalization Computed Characteristics

Demand Schedule: North High Peak Day ($a/\overline{Q_d}$ = 0.642)

Specific Speed : N_s = 3,000 N = 1,150 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 160.9 Ft.)						
8	2	0	165.5	-4.6	0	0	.2059	-0.1	.3208	0.2'*
(40%)		0.010	161.5	-0.6	4	0.025	.2058	3.9	.3206	
		0.025	155.5	5.4	10	0.062	.2057	9.9	.3204	
($\hat{y}$ =		0.10	125.6	35.3	40	0.249	.2058	39.8	.3205	
4.5')		0.20	85.8	75.1	80	0.497	.2058	79.6	.3205	
	3	0.010	159.6	1.3	4	0.025	.1940	5.7	.3022	
		0.025	151.7	9.2	10	0.062	.1827	13.7	.2846	
		0.10	115.8	45.1	40	0.249	.1586	49.6	.2471	
		0.20	70.4	90.5	80	0.497	.1475	95.0	.2298	
	4	0.010	155.8	5.0	4	0.025	.1768	9.5	.2754	
		0.025	145.8	15.1	10	0.062	.1580	19.6	.2462	
		0.10	105.7	55.2	40	0.249	.1265	59.7	.1970	
		0.20	57.0	103.9	80	0.497	.1139	108.4	.1774	
4	2	0	170.2	-9.3	0	0	.2055	-0.3	.3201	0.8'*
(20%)		0.010	166.2	-5.3	4	0.025	.2057	3.6	.3204	0.7'*
		0.025	160.3	0.6	10	0.062	.2059	9.6	.3207	0.7'*
($\hat{y}$ =		0.10	130.3	30.6	40	0.249	.2060	39.6	.3209	0.3'*
9.0')		0.20	90.2	70.7	80	0.497	.2056	79.7	.3203	0.2'*
	3	0.010	164.0	-3.1	4	0.025	.1938	5.9	.3018	0.5'*
		0.025	155.4	5.4	10	0.062	.1818	14.4	.2832	0.2'*
		0.10	118.8	42.1	40	0.249	.1580	51.0	.2461	
		0.20	73.0	87.8	80	0.497	.1471	96.8	.2292	
	4	0.010	159.2	1.6	4	0.025	.1752	10.6	.2729	
		0.025	148.8	12.1	10	0.062	.1572	21.1	.2448	
		0.10	107.9	53.0	40	0.249	.1262	61.9	.1966	
		0.20	58.8	102.1	80	0.497	.1135	111.1	.1769	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 101.3 Ft.)						
4	3	0.10	92.2	9.2	10	0.099	.1748	13.6	.2722	
(40%)		0.15	86.1	15.2	15	0.148	.1679	19.7	.2615	
	4	0.10	87.6	13.8	10	0.099	.1474	18.3	.2295	
		0.15	80.8	20.6	15	0.148	.1382	25.0	.2153	
2	3	0.10	95.9	5.4	10	0.099	.1740	14.4	.2711	0.3'*
(20%)		0.15	89.5	11.9	15	0.148	.1663	20.9	.2590	0.2'*
	4	0.10	90.4	11.0	10	0.099	.1473	20.0	.2294	
		0.15	83.4	18.0	15	0.148	.1381	26.9	.2152	

(*: approximate run)

TABLE NHA-3

Storage Equalization Computed Characteristics

Demand Schedule: North High Peak Day ($a/\overline{Q_d}$ = 0.642)

Specific Speed : N_s = 4,000 N = 1,750 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{Y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 Ft.)						
8 (40%)	2	0	196.4	-4.5	0	0	.2053	-0.0	.3197	
		0.010	192.4	-0.5	4	0.021	.2052	4.0	.3196	
		0.025	186.6	5.3	10	0.052	.2058	9.8	.3205	
($\hat{Y}$ =		0.10	156.7	35.2	40	0.208	.2057	39.7	.3204	
4.5')		0.20	116.8	75.0	80	0.417	.2057	79.5	.3204	
	3	0.010	190.8	1.1	4	0.021	.1987	5.5	.3095	
		0.025	182.7	9.2	10	0.052	.1905	13.7	.2967	
		0.10	145.5	46.4	40	0.208	.1686	50.9	.2627	
		0.20	98.9	93.0	80	0.417	.1562	97.5	.2432	
	4	0.010	186.4	5.4	4	0.021	.1861	9.9	.2899	
		0.025	175.1	16.8	10	0.052	.1701	21.3	.2649	
		0.10	131.7	60.2	40	0.208	.1385	64.7	.2158	
		0.20	80.6	111.3	80	0.417	.1238	115.8	.1929	
4 (20%)	2	0	201.2	-9.3	0	0	.2060	-0.4	.3209	0.3'*
		0.010	197.2	-5.3	4	0.021	.2060	3.6	.3209	0.3'*
		0.025	191.2	0.7	10	0.052	.2059	9.6	.3208	0.3'*
($\hat{Y}$ =		0.10	161.2	30.7	40	0.208	.2057	39.7	.3203	0.2'*
9.0')		0.20	121.0	70.8	80	0.417	.2053	79.8	.3198	
	3	0.010	195.1	-3.2	4	0.021	.1984	5.8	.3091	0.3'*
		0.025	186.4	5.4	10	0.052	.1898	14.4	.2956	
		0.10	148.7	43.2	40	0.208	.1682	52.2	.2621	
		0.20	101.7	90.2	80	0.417	.1558	99.1	.2427	
	4	0.010	190.0	1.8	4	0.021	.1854	10.8	.2888	
		0.025	178.3	13.6	10	0.052	.1696	22.6	.2641	
		0.10	134.0	57.9	40	0.208	.1383	66.9	.2153	
		0.20	82.4	109.4	80	0.417	.1235	118.4	.1923	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 Ft.)						
4 (40%)	3	0.10	111.7	9.2	10	0.083	.1843	13.7	.2871	
		0.15	105.4	15.5	15	0.124	.1779	20.0	.2771	
	4	0.10	105.4	15.4	10	0.083	.1601	19.9	.2494	
		0.15	97.9	23.0	15	0.124	.1508	27.4	.2348	
2 (20%)	3	0.10	115.4	5.4	10	0.083	.1835	14.4	.2859	
		0.15	108.8	12.0	15	0.124	.1770	21.0	.2757	
	4	0.10	108.4	12.4	10	0.083	.1594	21.4	.2484	
		0.15	100.8	20.1	15	0.124	.1503	29.1	.2341	

(*: approximate run)

TABLE TOA-1

Storage Equalization Computed Characteristics

Demand Schedule: Towson Typical Day ($a/\overline{Q_d}$ = 0.642)

Specific Speed : N_s = 2,200 N = 1,150 rpm

V, mg	n	Φ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 Ft.)						
8	2	0	250.0	-6.8	0	0	.2037	0.2	.3173	
(40%)		0.010	246.0	-2.8	4	0.016	.2038	4.2	.3175	
		0.025	240.3	3.0	10	0.041	.2048	9.9	.3189	
($\hat{y}$ =		0.10	210.5	32.8	40	0.164	.2052	39.7	.3197	
6.9')		0.20	170.6	72.7	80	0.329	.2053	79.6	.3197	
	3	0.010	243.7	-0.4	4	0.016	.1922	6.5	.2994	
		0.025	235.7	7.5	10	0.041	.1823	14.5	.2839	
		0.10	199.6	43.9	40	0.164	.1586	50.6	.2471	
4	2	0	256.5	-13.2	0	0	.2007	0.6	.3127	
(20%)		0.010	252.6	-9.3	4	0.016	.2012	4.6	.3134	
		0.025	246.6	-3.4	10	0.041	.2018	10.5	.3143	
($\hat{y}$ =		0.10	217.0	26.3	40	0.164	.2036	40.1	.3172	
13.9')		0.20	177.2	66.0	80	0.329	.2044	79.9	.3184	
	3	0.10	249.9	-6.7	4	0.016	.1901	7.2	.2960	
		0.025	241.5	1.7	10	0.041	.1803	15.6	.2808	
		0.10	204.7	38.6	40	0.164	.1577	52.4	.2457	
		0.20	158.8	84.4	80	0.329	.1465	98.3	.2282	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)						
4	3	0.10	145.9	7.3	10	0.065	.1744	14.3	.2716	
(40%)		0.15	139.9	13.4	15	0.098	.1678	20.3	.2614	
2	3	0.10	151.4	1.9	10	0.065	.1709	15.7	.2663	
(20%)		0.15	145.2	8.1	15	0.098	.1652	22.0	.2574	

TABLE TOA-2

Storage Equalization Computed Characteristics

Demand Schedule: Towson Typical Day ($a/\overline{Q_d}$ = 0.642)

Specific Speed : N_s = 3,000 N = 1,450 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 Ft.)						
8	2	0	225.9	-6.7	0	0	.2038	0.2	.3175	
(40%)		0.010	221.9	-2.7	4	0.018	.2039	4.2	.3176	
		0.025	216.2	3.0	10	0.046	.2049	9.9	.3191	
($\hat{y}$ =		0.10	186.3	32.8	40	0.183	.2052	39.7	.3196	
6.9')		0.20	146.5	72.7	80	0.365	.2053	79.6	.3197	
	3	0.010	219.5	-0.4	4	0.018	.1929	6.6	.3005	
		0.025	211.6	7.5	10	0.046	.1838	14.4	.2863	
		0.10	175.5	43.7	40	0.183	.1609	50.6	.2506	
		0.20	130.0	89.1	80	0.365	.1491	96.1	.2322	
	4	0.010	215.2	3.9	4	0.018	.1770	10.9	.2758	
		0.025	205.1	14.1	10	0.046	.1606	21.0	.2501	
4	2	0	232.3	-13.1	0	0	.2012	0.7	.3134	
(20%)		0.010	228.3	-9.2	4	0.018	.2016	4.7	.3140	
		0.025	222.4	-3.3	10	0.046	.2020	10.6	.3147	
($\hat{y}$ =		0.10	192.8	26.3	40	0.183	.2038	40.2	.3174	
13.9')		0.20	153.0	66.1	80	0.365	.2044	80.0	.3183	
	3	0.010	225.7	-6.6	4	0.018	.1910	7.3	.2976	
		0.025	217.5	1.7	10	0.046	.1821	15.5	.2836	
		0.10	180.5	38.6	40	0.183	.1595	52.5	.2485	
		0.20	134.4	84.7	80	0.365	.1479	98.6	.2304	
	4	0.010	220.9	-1.7	4	0.018	.1757	12.1	.2737	
		0.025	210.3	8.9	10	0.046	.1593	22.7	.2481	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)						
4	3	0.10	130.8	7.3	10	0.072	.1764	14.2	.2748	
(40%)		0.15	124.6	13.4	15	0.109	.1698	20.4	.2645	
	4	0.10	125.6	12.4	10	0.072	.1502	19.4	.2339	
2	3	0.10	136.3	1.7	10	0.072	.1735	15.6	.2703	
(20%)		0.15	130.1	8.0	15	0.109	.1677	21.8	.2611	
	4	0.10	130.7	7.5	10	0.072	.1485	21.4	.2313	

TABLE TOA-3

Storage Equalization Computed Characteristics

Demand Schedule: Towson Typical Day ($a/\overline{Q_d}$ = 0.642)

Specific Speed : N_s = 4,000 N = 1,750 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 Ft.)						
8	2	0	198.6	-6.8	0	0	.2041	0.2	.3180	
(40%)		0.010	194.7	-2.8	4	0.021	.2042	4.2	.3180	
		0.025	189.0	2.8	10	0.052	.2051	9.8	.3195	
($\hat{y}$ =		0.10	159.2	32.7	40	0.208	.2053	39.6	.3198	
6.9')		0.20	119.3	72.6	80	0.417	.2054	79.5	.3199	
	3	0.010	192.2	-0.4	4	0.021	.1952	6.6	.3040	
		0.025	184.2	7.7	10	0.052	.1871	14.6	.2915	
		0.10	147.3	44.6	40	0.208	.1651	51.5	.2572	
		0.20	101.2	90.7	80	0.417	.1527	97.7	.2378	
	4	0.010	187.3	4.6	4	0.021	.1810	11.5	.2820	
		0.025	176.6	15.3	10	0.052	.1658	22.2	.2583	
4	2	0	205.2	-13.4	0	0	.2026	0.5	.3156	
(20%)		0.010	201.3	-9.4	4	0.021	.2028	4.5	.3159	
		0.025	195.3	-3.4	10	0.052	.2031	10.4	.3163	
($\hat{y}$ =		0.10	165.7	26.2	40	0.208	.2042	40.1	.3180	
13.9')		0.20	125.8	66.0	80	0.417	.2046	79.9	.3186	
	3	0.010	198.6	-6.7	4	0.021	.1940	7.1	.3022	
		0.025	190.2	1.7	10	0.052	.1858	15.6	.2894	
		0.10	152.5	39.4	40	0.208	.1643	53.2	.2558	
		0.20	105.9	86.0	80	0.417	.1521	99.8	.2369	
	4	0.010	192.9	-1.0	4	0.021	.1793	12.8	.2792	
		0.025	181.9	10.0	10	0.052	.1648	23.8	.2567	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 Ft.)						
4	3	0.10	113.5	7.4	10	0.083	.1805	14.4	.2812	
(40%)		0.15	107.1	13.8	15	0.124	.1740	20.7	.2710	
	4	0.10	107.5	13.4	10	0.083	.1561	20.3	.2431	
		0.15	100.3	20.6	15	0.124	.1469	27.5	.2288	
2	3	0.10	119.1	1.8	10	0.083	.1781	15.6	.2774	
(20%)		0.15	112.7	8.2	15	0.124	.1723	22.0	.2683	
	4	0.10	112.5	8.3	10	0.083	.1545	22.2	.2406	
		0.15	105.1	15,8	15	0.124	.1457	29.6	.2270	

TABLE RS-1

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.766$

Specific Speed : $N_s = 2,200$ $N = 1,150$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a
			(Q_d = 20 mgd; E_{pd} = 243.3 Ft.)						
8	2	0	250.6	-7.3	0	0	.2424	.3	.3164
(40%)		0.05	231.0	12.3	20	0.082	.2438	19.9	.3183
		0.10	211.1	32.2	40	0.164	.2441	39.8	.3187
($\hat{y}$ =		0.15	191.2	52.1	60	0.247	.2443	59.7	.3189
7.6')		0.25	151.3	91.9	100	0.411	.2444	99.5	.3191
	2.5	0.05	227.7	15.6	20	0.082	.2262	23.2	.2954
		0.10	205.3	37.9	40	0.164	.2173	45.6	.2837
		0.15	183.3	59.9	60	0.247	.2119	67.6	.2766
		0.25	139.7	103.6	100	0.411	.2054	111.2	.2681
	3	0.05	223.0	20.2	20	0.082	.2079	27.9	.2715
		0.10	198.3	44.9	40	0.164	.1931	52.5	.2521
		0.15	174.6	68.7	60	0.247	.1847	76.3	.2411
		0.25	128.1	115.2	100	0.411	.1752	122.8	.2288
	4	0.05	211.9	31.3	20	0.082	.1747	39.0	.2281
		0.10	184.1	59.2	40	0.164	.1557	66.8	.2032
		0.15	158.5	84.8	60	0.247	.1459	92.4	.1905
		0.25	108.9	134.4	100	0.411	.1351	142.0	.1763
4	2	0	257.5	-14.3	0	0	.2392	1.0	.3123
(20%)		0.05	237.9	5.4	20	0.082	.2410	20.6	.3146
		0.10	218.2	25.1	40	0.164	.2422	40.3	.3161
($\hat{y}$ =		0.15	198.3	45.0	60	0.247	.2427	60.2	.3169
15.2')		0.25	158.5	84.8	100	0.411	.2434	100.0	.3177
	2.5	0.05	234.2	9.1	20	0.082	.2240	24.3	.2924
		0.10	211.6	31.6	40	0.164	.2159	46.9	.2818
		0.15	189.5	53.8	60	0.247	.2108	69.0	.2751
		0.25	145.7	97.6	100	0.411	.2046	112.8	.2671
	3	0.05	229.1	14.2	20	0.082	.2065	29.5	.2696
		0.10	204.0	39.3	40	0.164	.1922	54.5	.2509
		0.15	180.0	63.3	60	0.247	.1839	78.6	.2400
		0.25	133.1	110.2	100	0.411	.1746	125.4	.2279
	4	0.05	217.0	26.2	20	0.082	.1746	41.5	.2279
		0.10	188.8	54.4	40	0.164	.1559	69.7	.2035
		0.15	162.6	88.7	60	0.247	.1457	95.9	.1902
		0.25	112.5	130.7	100	0.411	.1348	146.0	.1760
			($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)						
4	3	0.10	146.2	7.1	10	0.065	.2118	14.7	.2765
(40%)		0.20	133.5	19.8	20	0.131	.1977	27.4	.2581
($\hat{y}$ =	4	0.10	139.5	13.7	10	0.065	.1814	21.3	.2369
7.6')		0.20	124.8	28.4	20	0.131	.1621	36.1	.2116

TABLE RS-2

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d}$ = 0.766

Specific Speed : N_s = 3,000 N = 1,450 rpm

Mean Demand : $\overline{Q_d}$ = 20 mgd E_{pd} = 219.1 ft.

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a
8	2	0	226.4	-7.3	0	0	.2426	0.3	.3167
(40%)		0.05	206.8	12.3	20	0.091	.2437	19.9	.3182
		0.10	186.9	32.2	40	0.183	.2441	39.8	.3187
($\hat{y}$ =		0.25	127.2	91.9	100	0.456	.2444	99.5	.3191
7.6')		0.50	28.3	190.8	200	0.913	.2433	198.4	.3176
	3	0.05	198.7	20.5	20	0.0913	.2096	28.1	.2736
		0.10	173.9	45.2	40	0.183	.1952	52.8	.2548
		0.25	103.8	115.4	100	0.456	.1771	123.0	.2312
	4	0.05	187.5	31.7	20	0.091	.1777	39.3	.2320
		0.10	159.4	59.8	40	0.183	.1590	67.4	.2076
		0.25	83.2	136.0	100	0.456	.1375	143.6	.1795
4	2	0.05	213.7	5.4	20	0.091	.2413	20.6	.3150
(20%)		0.10	193.9	25.2	40	0.183	.2422	40.4	.3162
		0.25	134.3	84.8	100	0.456	.2434	100.0	.3178
($\hat{y}$ =		0.50	34.6	184.5	200	0.913	.2439	199.7	.3184
15.2')	3	0.05	204.7	14.5	20	0.091	.2080	29.4	.2715
		0.10	179.6	39.5	40	0.183	.1940	54.7	.2533
		0.25	108.9	110.3	100	0.456	.1765	125.5	.2304
	4	0.05	192.7	26.5	20	0.091	.1777	41.7	.2319
		0.10	163.9	55.3	40	0.183	.1588	70.5	.2074
		0.25	83.2	132.4	100	0.456	.1372	147.6	.1791
8	2.5	0.05	203.5	15.7	20	0.091	.2271	23.3	.2964
(40%)		0.10	181.0	38.1	40	0.183	.2183	45.7	.2850
		0.15	159.0	60.2	60	0.274	.2129	67.8	.2780
		0.25	115.3	103.9	100	0.456	.2063	111.5	.2693
4	2.5	0.05	209.9	9.2	20	0.091	.2251	24.4	.2938
(20%)		0.10	187.4	31.8	40	0.183	.2170	47.0	.2833
		0.15	165.1	54.0	60	0.274	.2118	69.3	.2765
		0.25	121.2	97.9	100	0.456	.2056	113.1	.2683

TABLE RS-3

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.766$

Specific Speed : $N_s = 4{,}000$ $N = 1{,}750$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{Y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 Ft.)										
8	2	0	199.2	-7.4	0	0	.2431	0.3	.3174	
(40%)		0.05	179.7	12.2	20	0.104	.2442	19.8	.3188	
		0.10	159.8	32.1	40	0.208	.2443	39.7	.3190	
($\hat{Y}$ =		0.15	139.8	52.1	60	0.313	.2443	59.7	.3190	
7.6')		0.25	100.0	91.9	100	0.521	.2445	99.5	.3192	
	2.5	0.05	176.3	15.6	20	0.104	.2301	23.2	.3004	
		0.10	153.8	38.1	40	0.208	.2220	45.7	.2898	
		0.15	131.6	60.3	60	0.313	.2165	67.9	.2826	
		0.25	87.7	104.1	100	0.521	.2096	111.8	.2737	
	3	0.05	171.2	20.7	20	0.104	.2147	28.3	.2803	
		0.10	145.9	46.0	40	0.208	.2006	53.6	.2619	
		0.15	121.7	70.2	60	0.313	.1919	77.8	.2506	
		0.25	74.6	117.3	100	0.521	.1816	124.9	.2370	
	4	0.05	158.2	33.7	20	0.104	.1845	41.3	.2408	
		0.10	128.9	62.9	40	0.208	.1656	70.6	.2162	
		0.15	102.1	89.8	60	0.313	.1548	97.4	.2021	
		0.25	51.1	140.8	100	0.521	.1425	148.4	.1861	
4	2	0	206.2	-14.3	0	0	.2409	0.9	.3145	
(20%)		0.05	186.6	5.3	20	0.104	.2422	20.5	.3162	
		0.10	166.8	25.1	40	0.208	.2428	40.3	.3170	
($\hat{Y}$ =		0.15	147.0	44.9	60	0.313	.2432	60.1	.3175	
15.2')		0.25	107.1	84.8	100	0.521	.2436	100.0	.3180	
	2.5	0.05	182.9	8.9	20	0.104	.2285	24.2	.2984	
		0.10	160.2	31.7	40	0.208	.2208	46.9	.2883	
		0.15	137.8	54.0	60	0.313	.2155	69.3	.2814	
		0.25	93.8	98.1	100	0.521	.2089	113.4	.2727	
	3	0.05	177.4	14.5	20	0.104	.2134	29.7	.2786	
		0.10	151.7	40.2	40	0.208	.1997	55.4	.2607	
		0.15	127.2	64.7	60	0.313	.1911	79.9	.2495	
		0.25	79.7	112.1	100	0.521	.1809	127.4	.2362	
	4	0.05	163.5	28.4	20	0.104	.1844	43.6	.2407	
		0.10	133.6	58.3	40	0.208	.1654	73.5	.2159	
		0.15	106.4	85.5	60	0.313	.1546	100.7	.2018	
		0.25	54.9	136.9	100	0.521	.1423	152.2	.1858	
($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 Ft.)										
4	3	0.10	113.7	7.2	10	0.083	.2184	14.8	.2851	
(40%)		0.20	100.6	20.2	20	0.165	.2052	27.8	.2679	
($\hat{Y}$ =	4	0.10	105.9	14.9	10	0.083	.1907	22.6	.2489	
7.6')		0.20	90.5	30.4	20	0.165	.1721	38.0	.2247	

TABLE RA-1

Storage Equalization Computed Characterisitcs

Demand Schedule: Royal Oak Peak Day ($a/\overline{Q_d}$ = 0.766)

Specific Speed : N_s = 2,200 N = 1,150 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				(Q_d = 20 mgd; E_{pd} = 243.3 Ft.)						
8 (40%)	2	0	249.8	-6.5	0	0	.2460	.0	.3211	
		0.05	230.1	13.2	20	0.082	.2467	19.7	.3221	
		0.10	210.2	33.1	40	0.164	.2465	39.6	.3218	
($\hat{y}$ =		0.15	190.3	53.0	60	0.247	.2463	59.6	.3215	
6.6')		0.25	150.4	92.9	100	0.411	.2460	99.5	.3212	
	2.5	0.05	226.5	16.8	20	0.082	.2264	23.3	.2955	
		0.10	204.0	39.3	40	0.164	.2161	45.9	.2822	
		0.15	181.8	61.5	60	0.247	.2100	68.0	.2741	
		0.25	138.0	105.3	100	0.411	.2027	111.9	.2646	
	3	0.05	221.3	21.9	20	0.082	.2047	28.5	.2672	
		0.10	196.4	46.8	40	0.164	.1884	53.4	.2459	
		0.15	172.4	70.8	60	0.247	.1793	77.4	.2340	
		0.25	125.7	117.6	100	0.411	.1694	124.2	.2211	
	4	0.05	209.4	33.9	20	0.082	.1647	40.5	.2150	
		0.10	182.4	60.9	40	0.164	.1468	67.5	.1916	0.3'*
		0.15	158.4	84.9	60	0.247	.1395	91.4	.1821	0.5'*
		0.25	110.6	132.7	100	0.411	.1305	139.2	.1704	0.6'*
4 (20%)	2	0	256.2	-12.9	0	0	.2455	0.2	.3205	
		0.05	236.5	6.8	20	0.082	.2465	19.9	.3218	
		0.10	216.6	26.7	40	0.164	.2465	39.8	.3218	
($\hat{y}$ =		0.15	196.6	46.6	60	0.247	.2465	59.7	.3218	
13.1')		0.25	156.7	86.5	100	0.411	.2463	99.6	.3215	
	2.5	0.05	232.3	10.9	20	0.082	.2265	24.0	.2956	
		0.10	209.5	33.8	40	0.164	.2164	46.9	.2825	
		0.15	187.1	56.2	60	0.247	.2101	69.3	.2743	
		0.25	143.0	100.3	100	0.411	.2028	113.4	.2647	
	3	0.05	226.5	16.7	20	0.082	.2049	29.8	.2675	
		0.10	201.1	42.2	40	0.164	.1886	55.3	.2462	
		0.15	176.7	66.5	60	0.247	.1793	79.6	.2341	
		0.25	129.6	113.6	100	0.411	.1693	126.8	.2211	
	4	0.05	213.2	30.0	20	0.082	.1648	43.1	.2152	
		0.10	185.0	58.3	40	0.164	.1456	71.4	.1900	
		0.15	158.8	84.5	60	0.247	.1357	97.6	.1772	0.3'*
		0.25	111.0	132.3	100	0.411	.1280	145.4	.1671	0.7'*
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 Ft.)						
4 (40%)	3	0.10	144.9	8.4	10	0.065	.2105	14.9	.2747	
		0.20	132.0	21.3	20	0.131	.1944	27.8	.2538	
($\hat{y}$ =	4	0.10	137.5	15.8	10	0.065	.1721	22.3	.2247	
6.6')		0.20	122.9	30.4	20	0.131	.1522	37.0	.1987	

(*: approximate run)

TABLE RA-2

Storage Equalization Computed Characteristics

Demand Schedule: Royal Oak, Mich., Max. Day ($a/\overline{Q}_d = 0.766$)

Specific Speed : $N_s = 3{,}000$ $N = 1{,}450$ rpm

Mean Demand : $\overline{Q}_d = 20$ mgd $E_{pd} = 219.1$ ft.

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q}_d^2$	$\phi\overline{Q}_d^2/E_{pd}$	$U/\overline{Q}_d$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
8	2	0	225.6	-6.4	0	0	.2459	0.2	.3210	
(40%)		0.05	205.9	13.2	20	0.091	.2466	19.8	.3219	
		0.10	186.0	33.1	40	0.183	.2464	39.7	.3217	
($\hat{y}$ =		0.25	126.2	92.9	100	0.456	.2460	99.5	.3212	
6.6')		0.50	26.5	192.6	200	0.913	.2456	199.2	.3206	
	3	0.05	196.9	22.2	20	0.091	.2064	28.8	.2695	
		0.10	171.9	47.2	40	0.183	.1904	53.8	.2486	
		0.25	101.4	117.8	100	0.456	.1714	124.4	.2238	
	4	0.05	185.1	34.0	20	0.091	.1687	40.6	.2202	
		0.10	157.5	61.6	40	0.183	.1496	68.2	.1953	
		0.25	85.1*	134.0*	100	0.456	.1323*	140.6*	.1727*	0.3'
4	2	0	231.9	-12.8	0	0	.2457	0.3	.3208	
(20%)		0.05	212.3	6.9	20	0.091	.2465	20.0	.3218	
		0.10	192.4	26.8	40	0.183	.2466	39.9	.3219	
($\hat{y}$ =		0.25	132.5	86.6	100	0.456	.2462	99.7	.3214	
13.1')		0.50	32.7	186.4	200	0.913	.2457	199.5	.3208	
	3	0.05	202.2	16.9	20	0.091	.2066	30.0	.2697	
		0.10	176.7	42.4	40	0.183	.1906	55.5	.2488	
		0.25	105.3	113.8	100	0.456	.1713	126.9	.2236	
	4	0.05	189.1	30.0	20	0.091	.1688	43.1	.2204	
		0.10	159.9	59.2	40	0.183	.1486	72.3	.1940	
		0.25	85.9*	133.3*	100	0.456	.1307*	146.4*	.1706*	0.5' *
8	2.5	0.05	202.3	16.8	20	0.091	.2273	23.4	.2967	
(40%)		0.10	179.6	39.5	40	0.183	.2171	46.1	.2834	
		0.15	157.4	61.8	60	0.274	.2108	68.3	.2752	
		0.25	113.5	105.7	100	0.456	.2036	112.2	.2658	
4	2.5	0.05	208.1	11.1	20	0.091	.2274	24.2	.2969	
(20%)		0.10	185.2	33.9	40	0.183	.2174	47.0	.2838	
		0.15	162.7	56.4	60	0.274	.2111	69.5	.2756	
		0.25	118.5	100.6	100	0.456	.2037	113.7	.2659	

(*: approximate run).

TABLE RA-3

Storage Equalization Computed Characteristics

Demand Schedule: Royal Oak Peak Day ($a/\overline{Q}_d$ = 0.766)

Specific Speed : N_s = 4,000 N = 1,750 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q}_d^{\,2}$	$\phi\overline{Q}_d^{\,2}/E_{pd}$	$U/\overline{Q}_d$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
($\overline{Q}_d$ = 20 mgd; E_{pd} = 191.9 Ft.)										
8	2	0	198.3	-6.5	0	0	.2456	0.1	.3207	
(40%)		0.05	178.7	13.2	20	0.104	.2463	19.7	.3215	
		0.10	158.9	33.0	40	0.208	.2463	39.6	.3215	
($\hat{y}$ =		0.15	138.9	53.0	60	0.313	.2460	59.6	.3212	
6.6')		0.25	99.0	92.8	100	0.521	.2459	99.4	.3210	
	2.5	0.05	175.1	16.8	20	0.104	.2303	23.3	.3006	
		0.10	152.4	39.5	40	0.208	.2209	46.0	.2884	
		0.15	130.0	61.9	60	0.313	.2146	68.4	.2802	
		0.25	85.8	106.0	100	0.521	.2069	112.6	.2701	
	3	0.05	169.4	22.5	20	0.104	.2118	29.0	.2765	
		0.10	143.8	48.1	40	0.208	.1960	54.7	.2558	
		0.15	119.3	72.5	60	0.313	.1866	79.1	.2436	
		0.25	71.9	119.9	100	0.521	.1757	126.5	.2293	
	4	0.05	155.2	36.7	20	0.104	.1752	43.3	.2287	
		0.10	125.8	66.1	40	0.208	.1551	72.6	.2025	
		0.15	101.7	90.2	60	0.313	.1478	96.7	.1930	0.4'*
		0.25	53.8	138.0	100	0.521	.1382	144.6	.1805	0.5'*
4	2	0	204.8	-12.9	0	0	.2461	0.2	.3213	
(20%)		0.05	185.1	6.8	20	0.104	.2466	19.9	.3219	
		0.10	165.2	26.7	40	0.208	.2464	39.8	.3217	
($\hat{y}$ =		0.15	145.2	46.7	60	0.313	.2463	59.8	.3215	
13.1')		0.25	105.3	86.6	100	0.521	.2461	99.7	.3213	
	2.5	0.05	181.0	10.9	20	0.104	.2306	24.0	.3010	
		0.10	158.0	33.9	40	0.208	.2211	47.0	.2887	
		0.15	135.4	56.5	60	0.313	.2148	69.6	.2805	
		0.25	90.9	100.9	100	0.521	.2071	114.0	.2703	
	3	0.05	174.7	17.1	20	0.104	.2121	30.2	.2768	
		0.10	148.6	43.3	40	0.208	.1962	56.4	.2562	
		0.15	123.8	68.1	60	0.313	.1867	81.2	.2437	
		0.25	76.0	115.9	100	0.521	.1756	129.0	.2293	
	4	0.05	159.3	32.6	20	0.104	.1753	45.7	.2289	
		0.10	129.2	62.6	40	0.208	.1551	75.7	.2025	
		0.15	102.1	89.8	60	0.313	.1444	102.9	.1884	0.2'*
		0.25	54.3	137.6	100	0.521	.1359	150.7	.1774	0.7'*
($\overline{Q}_d$ = 10 mgd; E_{pd} = 120.9 Ft.)										
4	3	0.10	112.3	8.6	10	0.083	.2171	15.1	.2834	
(40%)		0.20	99.1	21.8	20	0.165	.2020	28.4	.2637	
($\hat{y}$ =	4	0.10	103.7	17.2	10	0.083	.1824	23.7	.2382	
6.6')		0.20	88.0	32.8	20	0.165	.1620	39.4	.2115	

(*: approximate run)

TABLE LACS-1

Storage Utilization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q}_d = 0.854$

Specific Speed : $N_s = 2,200$ $N = 1,150$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q}_d^2$	$\phi\overline{Q}_d^2/E_{pd}$	$U/\overline{Q}_d$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
			($\overline{Q}_d$ = 20 mgd; E_{pd} = 243.3 Ft.)							
8	2	0	251.4	-8.2	0	0	.2702	0.3	.3164	
(40%)		0.05	231.8	11.5	20	0.082	.2717	20.0	.3181	
		0.10	211.9	31.3	40	0.164	.2720	39.8	.3185	
($\hat{y}$ =		0.15	192.0	51.2	60	0.247	.2722	59.7	.3188	
8.5')		0.25	152.2	91.1	100	0.411	.2724	99.6	.3190	
	2.5	0.05	227.1	16.1	20	0.082	.2499	24.6	.2926	
		0.10	203.9	39.3	40	0.164	.2394	47.8	.2804	
		0.15	181.1	62.2	60	0.247	.2329	70.7	.2728	
		0.25	136.0	107.2	100	0.411	.2255	115.7	.2641	
	3	0.05	220.4	22.9	20	0.082	.2264	31.4	.2651	
		0.10	193.9	49.4	40	0.164	.2093	57.8	.2451	
		0.15	168.8	74.5	60	0.247	.1999	83.0	.2341	
		0.25	120.1	123.1	100	0.411	.1898	131.6	.2222	
	4	0.05	205.2	38.0	20	0.082	.1864	46.5	.2183	
		0.10	177.5	65.8	40	0.164	.1694	74.3	.1983	0.4'*
		0.15	152.6	90.6	60	0.247	.1613	99.1	.1888	0.7'*
		0.25	103.0	140.2	100	0.411	.1510	148.7	.1769	0.8'*
4	2	0	259.1	-15.8	0	0	.2666	1.2	.3122	0.2'*
(20%)		0.05	239.5	3.8	20	0.082	.2685	20.8	.3144	
		0.10	219.8	23.5	40	0.164	.2698	40.5	.3160	
($\hat{y}$ =		0.15	199.9	43.3	60	0.247	.2705	60.3	.3168	
17.0')		0.25	160.2	83.1	100	0.411	.2713	100.1	.3177	
	2.5	0.05	234.4	8.9	20	0.082	.2476	25.9	.2899	
		0.10	210.9	32.4	40	0.164	.2379	49.4	.2785	
		0.15	187.9	55.4	60	0.247	.2319	72.3	.2715	
		0.25	142.6	100.7	100	0.411	.2247	117.7	.2631	
	3	0.05	226.9	16.4	20	0.082	.2253	33.3	.2638	
		0.10	200.1	43.2	40	0.164	.2089	60.2	.2446	
		0.15	174.5	68.7	60	0.247	.1994	85.7	.2335	
		0.25	125.3	118.0	100	0.411	.1890	135.0	.2213	
	4	0.05	210.7	32.6	20	0.082	.1863	49.6	.2181	
		0.10	180.0	63.2	40	0.164	.1662	80.2	.1946	
		0.15	153.0	90.3	60	0.247	.1566	107.3	.1834	0.3'*
		0.25	103.5	139.8	100	0.411	.1478	156.8	.1731	0.9'*
			($\overline{Q}_d$ = 10 mgd; E_{pd} = 153.3 Ft.)							
4	2.5	0.10	149.0	4.3	10	0.065	.2519	12.8	.2950	
(40%)		0.30	125.6	27.7	30	0.196	.2362	36.2	.2766	
	3	0.10	145.0	8.2	10	0.065	.2311	16.7	.2706	
($\hat{y}$ =		0.30	118.4	34.9	30	0.196	.2051	43.4	.2401	
8.5')	4	0.10	135.5	17.7	10	0.065	.1927	26.2	.2256	
		0.30	105.8	47.4	30	0.196	.1625	55.9	.1903	0.2'*

(*: approximate run)

TABLE LACS-2

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.854$

Specific Speed : $N_s = 3,000$ $N = 1,450$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 Ft.)						
8	2	0	227.2	-8.1	0	0	.2705	0.4	.3167	
(40%)		0.05	207.7	11.5	20	0.091	.2719	20.0	.3183	
		0.10	187.8	31.4	40	0.183	.2721	39.9	.3186	
($\hat{y}$ =		0.15	167.9	51.3	60	0.274	.2722	59.8	.3188	
8.5')		0.25	128.0	91.1	100	0.456	.2724	99.6	.3190	
	2.5	0.05	202.9	16.2	20	0.091	.2510	24.7	.2939	
		0.10	179.5	39.6	40	0.183	.2406	48.1	.2817	
		0.15	156.7	62.4	60	0.274	.2343	70.9	.2744	
		0.25	111.6	107.5	100	0.456	.2267	116.0	.2655	
	3	0.05	196.0	23.1	20	0.091	.2286	31.6	.2677	
		0.10	169.8	49.4	40	0.183	.2123	57.9	.2486	
		0.15	144.4	74.8	60	0.274	.2025	83.3	.2371	
		0.25	95.3	123.8	100	0.456	.1918	132.3	.2246	
	4	0.05	180.3	38.8	20	0.091	.1899	47.3	.2223	
		0.10	151.9	67.2	40	0.183	.1726	75.7	.2021	0.4'*
		0.15	127.1	92.0	60	0.274	.1646	100.5	.1927	0.7'*
		0.25	77.5	141.7	100	0.456	.1542	150.2	.1805	0.9'*
4	2	0	234.8	-15.6	0	0	.2669	1.4	.3126	
(20%)		0.05	215.2	3.9	20	0.091	.2689	20.9	.3149	
		0.10	195.5	23.6	40	0.183	.2700	40.6	.3161	
($\hat{y}$ =		0.15	175.7	43.4	60	0.274	.2707	60.4	.3170	
17.0')		0.25	136.0	83.2	100	0.456	.2713	100.2	.3177	
	2.5	0.05	210.1	9.1	20	0.091	.2489	26.1	.2914	
		0.10	186.5	32.6	40	0.183	.2391	49.6	.2800	
		0.15	163.5	55.6	60	0.274	.2332	72.6	.2730	
		0.25	118.2	101.0	100	0.456	.2259	118.0	.2645	
	3	0.05	202.7	16.4	20	0.091	.2275	33.4	.2664	
		0.10	176.0	43.2	40	0.183	.2116	60.2	.2477	
		0.15	150.2	68.9	60	0.274	.2020	85.9	.2365	
		0.25	100.9	118.3	100	0.456	.1913	135.2	.2241	
	4	0.05	185.8	33.4	20	0.091	.1897	50.4	.2221	
		0.10	154.6	64.5	40	0.183	.1697	81.5	.1987	
		0.15	127.5	91.7	60	0.274	.1601	108.7	.1875	0.4'*
		0.25	77.9	141.2	100	0.456	.1511	158.2	.1769	1.0'*
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)						
4	2.5	0.10	133.6	4.4	10	0.072	.2529	12.9	.2961	
(40%)		0.30	110.2	27.8	30	0.217	.2374	36.3	.2780	
	3	0.10	129.7	8.3	10	0.072	.2332	16.8	.2731	
($\hat{y}$ =		0.30	103.2	34.8	30	0.217	.2079	43.3	.2434	
8.5')	4	0.10	120.2	17.8	10	0.072	.1968	26.3	.2305	
		0.30	89.8	48.3	30	0.217	.1660	56.8	.1943	

(*: approximate run)

TABLE LACS-3

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q}_d = 0.854$

Specific Speed : $N_s = 4,000$ $N = 2,050$ rpm

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q}_d^{\,2}$	$\phi\overline{Q}_d^{\,2}/E_{pd}$	$U/\overline{Q}_d$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
				($\overline{Q}_d$ = 20 mgd; E_{pd} = 236.9 Ft.)						
8	2	0	245.2	-8.2	0	0	.2713	0.3	.3177	
(40%)		0.05	225.7	11.3	20	0.084	.2723	19.8	.3188	
		0.10	205.8	31.2	40	0.169	.2724	39.6	.3190	
($\hat{y}$ =		0.15	185.9	51.1	60	0.253	.2724	59.6	.3190	
8.5')		0.25	146.0	90.9	100	0.422	.2725	99.4	.3191	
	2.5	0.05	220.8	16.1	20	0.084	.2573	24.6	.3012	
		0.10	197.1	39.8	40	0.169	.2481	48.3	.2906	
		0.15	173.9	63.1	60	0.253	.2418	71.6	.2831	
		0.25	128.3	108.7	100	0.422	.2337	117.2	.2736	
	3	0.05	212.7	24.2	20	0.084	.2391	32.7	.2799	
		0.10	184.9	52.0	40	0.169	.2233	60.5	.2615	
		0.15	158.7	78.3	60	0.253	.2134	86.8	.2499	
		0.25	108.7	128.3	100	0.422	.2014	136.8	.2358	
	4	0.05	192.2	44.8	20	0.084	.2027	53.3	.2374	
		0.10	159.1	77.9	40	0.169	.1833	86.2	.2146	0.2'*
		0.15	134.2	102.7	60	0.253	.1758	111.2	.2059	0.6'*
		0.25	84.8	152.2	100	0.422	.1662	160.7	.1946	1.0'*
4	2	0	253.1	-16.1	0	0	.2697	0.9	.3158	
(20%)		0.05	233.5	3.4	20	0.084	.2707	20.4	.3170	
($\hat{y}$ =		0.10	213.7	23.3	40	0.169	.2711	40.3	.3175	
		0.15	193.8	43.2	60	0.253	.2714	60.1	.3178	
17.0')		0.25	153.9	83.0	100	0.422	.2717	100.0	.3181	
	2.5	0.05	228.3	8.7	20	0.084	.2560	25.7	.2997	
		0.10	204.3	32.6	40	0.169	.2471	49.6	.2894	
		0.15	180.9	56.0	60	0.253	.2410	73.0	.2822	
		0.25	135.0	101.9	100	0.422	.2330	118.9	.2728	
	3	0.05	219.7	17.3	20	0.084	.2380	34.3	.2787	
		0.10	191.4	45.5	40	0.169	.2225	62.5	.2606	
		0.15	164.8	72.1	60	0.253	.2127	89.1	.2491	
		0.25	114.3	122.6	100	0.422	.2008	139.6	.2351	
	4	0.05	198.1	38.9	20	0.084	.2028	55.9	.2374	
		0.10	163.6	73.3	40	0.169	.1825	90.1	.2137	
		0.15	134.7	102.3	60	0.253	.1727	119.2	.2022	0.4'*
		0.25	85.2	151.8	100	0.422	.1636	168.6	.1916	1.3'*
				($\overline{Q}_d$ = 10 mgd; E_{pd} = 149.3 Ft.)						
4	2.5	0.10	145.1	4.2	10	0.067	.2592	12.6	.3035	
(40%)		0.30	121.3	27.9	30	0.201	.2452	36.4	.2872	
	3	0.10	140.6	8.7	10	0.067	.2433	17.2	.2849	
($\hat{y}$ =		0.30	112.6	36.7	30	0.201	.2189	45.2	.2564	
8.5')	4	0.10	128.2	21.1	10	0.067	.2095	29.6	.2453	
		0.30	94.5	54.8	30	0.201	.1778	63.3	.2082	

(*: approximate run)

TABLE LACA-1

Storage Equalization Computed Characteristics

Demand Schedule: Los Angeles County Peak Day ($a/\overline{Q}_d$ = 0.854)

Specific Speed: N_s = 2,200 N = 1,150 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q}_d^{\,2}$	$\phi\overline{Q}_d^{\,2}/E_{pd}$	$U/\overline{Q}_d$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q}_d$ = 20 mgd; E_{pd} = 243.3 Ft.)						
8	2	0	251.6	-8.3	0	0	.2711	0.4	.3174	
(40%)		0.05	231.9	11.3	20	0.082	.2722	20.0	.3187	
		0.10	212.1	31.2	40	0.164	.2723	39.8	.3189	
($\hat{y}$ =		0.15	192.2	51.1	60	0.247	.2723	59.7	.3189	
8.6')		0.25	152.3	90.9	100	0.411	.2723	99.6	.3189	
	2.5	0.05	227.6	15.6	20	0.082	.2518	24.3	.2949	
		0.10	205.4	38.7	40	0.164	.2415	47.4	.2827	
		0.15	181.8	61.4	60	0.247	.2351	70.1	.2753	
		0.25	137.1	106.2	100	0.411	.2277	114.8	.2666	
	3	0.05	221.3	22.0	20	0.082	.2300	30.7	.2693	
		0.10	195.2	48.1	40	0.164	.2133	56.8	.2498	
		0.15	170.2	73.1	60	0.247	.2038	81.7	.2386	
		0.25	121.8	121.5	100	0.411	.1933	130.1	.2263	
	4	0.05	206.7	36.6	20	0.082	.1910	45.2	.2237	
		0.10	177.1	66.2	40	0.164	.1704	74.8	.1995	
		0.15	149.8	93.5	60	0.247	.1595	102.1	.1867	
		0.25	97.4	145.9	100	0.411	.1475	154.6	.1728	
4	2	0	259.3	-16.0	0	0	.2685	1.3	.3144	
(20%)		0.05	239.7	3.5	20	0.082	.2702	20.8	.3164	
		0.10	220.0	23.2	40	0.164	.2710	40.5	.3174	
($\hat{y}$ =		0.15	200.2	43.1	60	0.247	.2714	60.4	.3178	
17.3')		0.25	160.4	82.8	100	0.411	.2718	100.1	.3183	
	2.5	0.05	234.9	8.4	20	0.082	.2503	25.7	.2931	
		0.10	211.6	31.7	40	0.164	.2406	49.0	.2817	
		0.15	188.8	54.5	60	0.247	.2346	71.8	.2747	
		0.25	143.8	99.5	100	0.411	.2273	116.8	.2661	
	3	0.05	228.0	15.3	20	0.082	.2291	32.6	.2683	
		0.10	201.4	41.9	40	0.164	.2127	59.2	.2491	
		0.15	176.2	67.1	60	0.247	.2034	84.4	.2382	
		0.25	127.4	115.9	100	0.411	.1929	133.2	.2259	
	4	0.05	212.3	31.0	20	0.082	.1905	48.2	.2230	
		0.10	182.0	61.2	40	0.164	.1700	78.5	.1991	
		0.15	154.3	89.0	60	0.247	.1590	106.3	.1862	
		0.25	101.4	141.8	100	0.411	.1472	159.1	.1724	
				($\overline{Q}_d$ = 10 mgd; E_{pd} = 153.3 Ft.)						
4	2.5	0.10	149.2	4.0	10	0.065	.2542	12.7	.2976	
(40%)		0.30	126.1	27.2	30	0.196	.2386	35.8	.2794	
	3	0.10	145.5	7.7	10	0.065	.2349	16.4	.2750	
($\hat{y}$ =		0.30	119.2	34.0	30	0.196	.2091	42.7	.2448	
8.6')	4	0.10	136.8	16.5	10	0.065	.1981	25.1	.2320	
		0.30	106.8	46.5	30	0.196	.1655	55.1	.1938	

(*: approximate run)

TABLE LACA-2

Storage Equalization Computed Characteristics

Demand Schedule: Los Angeles County Peak Day ($a/\overline{Q_d}$ = 0.854)

Specific Speed : N_s = 3,000 N = 1,450 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 Ft.)						
8	2	0	227.3	-8.2	0	0	.2712	0.4	.3176	
(40%)		0.05	207.8	11.3	20	0.091	.2723	20.0	.3188	
		0.10	187.9	31.2	40	0.183	.2723	39.9	.3188	
($\hat{y}$ =		0.15	168.0	51.1	60	0.274	.2723	59.8	.3189	
8.6')		0.25	128.2	90.9	100	0.456	.2723	99.6	.3189	
	2.5	0.05	203.3	15.8	20	0.091	.2527	24.4	.2959	
		0.10	180.2	39.0	40	0.183	.2426	47.6	.2841	
		0.15	157.5	61.7	60	0.274	.2364	70.3	.2768	
		0.25	112.6	106.5	100	0.456	.2288	115.2	.2679	
	3	0.05	196.9	22.2	20	0.091	.2321	30.9	.2718	
		0.10	170.8	48.3	40	0.183	.2158	56.9	.2528	
		0.15	146.0	73.1	60	0.274	.2064	81.8	.2417	
		0.25	97.3	121.9	100	0.456	.1955	130.5	.2289	
	4	0.05	181.9	37.3	20	0.091	.1946	45.9	.2278	
		0.10	151.7	67.5	40	0.183	.1739	76.1	.2037	
		0.15	124.0	95.2	60	0.274	.1628	103.8	.1906	
		0.25	71.0	148.1	100	0.456	.1504	156.7	.1761	
4	2	0	235.0	-15.9	0	0	.2689	1.4	.3149	
(20%)		0.05	215.4	3.7	20	0.091	.2703	21.0	.3165	
		0.10	195.8	23.4	40	0.183	.2711	40.7	.3174	
($\hat{y}$ =		0.15	176.0	43.1	60	0.274	.2715	60.4	.3180	
17.3')		0.25	136.2	82.9	100	0.456	.2718	100.2	.3182	
	2.5	0.05	210.6	8.5	20	0.091	.2514	25.8	.2944	
		0.10	187.3	31.8	40	0.183	.2419	49.1	.2832	
		0.15	164.4	54.7	60	0.274	.2358	72.0	.2761	
		0.25	119.4	99.7	100	0.456	.2285	117.0	.2676	
	3	0.05	203.7	15.5	20	0.091	.2312	32.8	.2707	
		0.10	177.2	41.9	40	0.183	.2153	59.2	.2521	
		0.15	151.8	67.3	60	0.274	.2058	84.6	.2410	
		0.25	102.9	116.2	100	0.456	.1951	133.5	.2285	
	4	0.05	187.6	31.5	20	0.091	.1941	48.8	.2273	
		0.10	156.7	62.4	40	0.183	.1736	79.7	.2033	
		0.15	128.6	90.6	60	0.274	.1624	107.9	.1902	
		0.25	75.1	144.0	100	0.456	.1500	161.3	.1756	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 Ft.)						
4	2.5	0.10	134.0	4.1	10	0.072	.2551	13.7	.2988	
(40%)		0.30	110.7	27.4	30	0.217	.2398	36.0	.2808	
	3	0.10	130.3	7.8	10	0.072	.2369	16.4	.2774	
($\hat{y}$ =		0.30	104.0	34.0	30	0.217	.2117	42.7	.2479	
8.6')	4	0.10	121.2	16.8	10	0.072	.2014	25.5	.2359	
		0.30	90.7	47.4	30	0.217	.1690	56.0	.1979	

TABLE LACA-3

Storage Equalization Computed Characteristics

Demand Schedule: Los Angeles County Peak Day ($a/\overline{Q}_d$ = 0.854)

Specific Speed : N_s = 4,000   N = 2,050 rpm

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q}_d^{\,2}$	$\phi\overline{Q}_d^{\,2}/E_{pd}$	$U/\overline{Q}_d$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q}_d$ = 20 mgd; E_{pd} = 236.9 Ft.)						
8	2	0	245.3	-8.4	0	0	.2715	0.3	.3180	
(40%)		0.05	225.8	11.1	20	0.084	.2723	19.8	.3189	
		0.10	205.9	31.0	40	0.169	.2723	39.7	.3189	
($\hat{y}$ =		0.15	186.0	50.9	60	0.253	.2723	59.6	.3189	
8.6')		0.25	146.1	90.8	100	0.422	.2723	99.5	.3188	
	2.5	0.05	221.4	15.6	20	0.084	.2584	24.2	.3026	
		0.10	197.8	39.1	40	0.169	.2496	47.8	.2923	
		0.15	174.8	62.1	60	0.253	.2436	70.8	.2852	
		0.25	129.4	107.5	100	0.422	.2355	116.2	.2758	
	3	0.05	213.8	23.1	20	0.084	.2419	31.8	.2833	
		0.10	186.3	50.6	40	0.169	.2266	59.3	.2654	
		0.15	160.4	76.5	60	0.253	.2169	85.2	.2540	
		0.25	110.6	126.3	100	0.422	.2050	135.0	.2400	
	4	0.05	194.1	42.9	20	0.084	.2081	51.5	.2437	
		0.10	161.3	75.6	40	0.169	.1875	84.3	.2196	
		0.15	131.4	105.5	60	0.253	.1753	114.2	.2053	
		0.25	75.5	161.5	100	0.422	.1618	170.1	.1895	
4	2	0	253.3	-16.4	0	0	.2708	0.9	.3170	
(20%)		0.05	233.8	3.2	20	0.084	.2715	20.5	.3179	
		0.10	213.9	23.0	40	0.169	.2717	40.3	.3182	
($\hat{y}$ =		0.15	194.0	42.9	60	0.253	.2719	60.2	.3183	
17.3')		0.25	154.2	82.7	100	0.422	.2719	100.0	.3184	
	2.5	0.05	228.9	8.1	20	0.084	.2577	25.4	.3018	
		0.10	205.2	31.8	40	0.169	.2492	49.1	.2918	
		0.15	181.9	55.0	60	0.253	.2432	72.3	.2847	
		0.25	136.3	100.6	100	0.422	.2352	117.9	.2755	
	3	0.05	220.9	16.0	20	0.084	.2414	33.3	.2827	
		0.10	193.0	43.9	40	0.169	.2263	61.2	.2650	
		0.15	166.8	70.2	60	0.253	.2166	87.5	.2537	
		0.25	116.5	120.4	100	0.422	.2047	137.7	.2397	
	4	0.05	200.1	36.8	20	0.084	.2077	54.1	.2432	
		0.10	166.4	70.5	40	0.169	.1871	87.8	.2191	
		0.15	136.4	100.6	60	0.253	.1750	117.9	.2049	
		0.25	79.8	157.2	100	0.422	.1615	174.5	.1891	
				($\overline{Q}_d$ = 10 mgd; E_{pd} = 149.3 Ft.)						
4	2.5	0.10	145.5	3.8	10	0.067	.2607	12.4	.3052	
(40%)		0.30	121.9	27.4	30	0.201	.2471	36.1	.2893	
	3	0.10	141.3	8.0	10	0.067	.2464	16.6	.2885	
($\hat{y}$ =		0.30	113.6	35.7	30	0.201	.2225	44.3	.2606	
8.6')	4	0.10	129.6	19.7	10	0.067	.2147	28.4	.2514	
		0.30	96.3	53.0	30	0.201	.1823	61.6	.2134	

TABLE Q_p-1

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for Tri-Service, in same order as runs listed in TRI tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule

TABLE TRIS-1		TABLE TRIS-2		TABLE TRIS-3		TABLE TRIA-1		TABLE TRIA-2		TABLE TRIA-3	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.965	1.035	.967	1.032	.979	1.021	.954	1.024	.957	1.022	.973	1.014
.973	1.027	.974	1.025	.982	1.017	.965	1.019	.967	1.018	.977	1.012
.978	1.041	.979	1.020	.985	1.015	.972	1.015	.972	1.015	.980	1.011
.901	1.018	.982	1.017	.986	1.013	.976	1.013	.977	1.013	.983	1.010
.985	1.013	.986	1.013	.989	1.010	.982	1.010	.982	1.010	.986	1.008
.972	1.028	.973	1.027	.981	1.019	.952	1.023	.953	1.022	.968	1.016
.971	1.028	.972	1.027	.979	1.020	.946	1.024	.947	1.023	.960	1.018
.969	1.029	.970	1.028	.976	1.022	.942	1.029	.943	1.027	.955	1.021
.965	1.032	.966	1.031	.972	1.025	.936	1.036	.937	1.035	.948	1.029
.965	1.034	.966	1.032	.976	1.023	.932	1.029	.935	1.028	.953	1.021
.956	1.040	.957	1.038	.967	1.029	.917	1.043	.920	1.041	.937	1.031
.949	1.045	.950	1.044	.960	1.034	.909	1.054	.910	1.052	.927	1.041
.941	1.052	.942	1.051	.950	1.043	.898	1.067	.900	1.065	.913	1.054
.946	1.047	.948	1.045	.961	1.033	.897	1.051	.899	1.048	.923	1.034
.927	1.062	.929	1.060	.943	1.047	.872	1.078	.874	1.075	.908	1.057
.917	1.072	.919	1.070	.932	1.057	.858	1.093	.861	1.090	.880	1.073
.906	1.084	.907	1.082	.918	1.070	.844	1.111	.846	1.109	.862	1.093
.831	1.065	.934	1.060	.959	1.040	.907	1.045	.912	1.042	.946	1.028
.947	1.051	.949	1.048	.965	1.034	.929	1.036	.932	1.034	.954	1.024
.956	1.042	.958	1.040	.970	1.030	.943	1.029	.945	1.028	.961	1.021
.964	1.036	.965	1.034	.973	1.026	.953	1.025	.954	1.024	.965	1.019
.972	1.027	.973	1.027	.978	1.021	.964	1.019	.965	1.019	.972	1.015
.949	1.051	.951	1.048	.966	1.034	.925	1.037	.927	1.035	.950	1.025
.957	1.045	.958	1.043	.969	1.032	.926	1.033	.928	1.032	.946	1.025
.950	1.041	.961	1.040	.969	1.031	.926	1.033	.928	1.032	.943	1.026
.960	1.039	.961	1.037	.968	1.031	.926	1.036	.927	1.035	.939	1.029
.948	1.054	.950	1.051	.964	1.036	.909	1.039	.912	1.037	.937	1.028
.948	1.052	.950	1.049	.962	1.038	.902	1.046	.904	1.044	.925	1.033
.945	1.053	.946	1.051	.957	1.041	.912	1.053	.899	1.051	.918	1.040
.939	1.056	.940	1.055	.949	1.046	.891	1.066	.892	1.064	.907	1.053
.937	1.062	.939	1.059	.955	1.043	.880	1.056	.883	1.053	.910	1.038
.925	1.069	.926	1.067	.941	1.052	.862	1.077	.865	1.074	.888	1.056
.915	1.076	.917	1.073	.930	1.060	.852	1.093	.854	1.090	.875	1.072
.005	1.085	.906	1.084	.918	1.072	.840	1.111	.842	1.108	.858	1.092
.955	1.046	.957	1.043	.970	1.030	.922	1.034	.924	1.033	.947	1.023
.945	1.052	.947	1.050	.962	1.036	.893	1.048	.897	1.045	.923	1.032
.919	1.077	.923	1.073	.946	1.053	.879	1.054	.883	1.052	.918	1.039
.921	1.079	.924	1.076	.946	1.056	.861	1.061	.866	1.058	.899	1.042

TABLE Q_p-2

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for Belmont H.S., in some order as runs listed in BS & BA tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule

TABLE BS-1		TABLE BS-2		TABLE BS-3		TABLE BS-5		TABLE BA-1		TABLE BA-2	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.936	1.060	.949	1.048	.938	1.058	.958	1.044	.919	1.055	.892	1.071
.942	1.055	.960	1.038	.943	1.054	.956	1.043	.931	1.048	.928	1.051
.946	1.050	.979	1.020	.947	1.050	.951	1.045	.946	1.039	.968	1.023
.963	1.035	.987	1.012	.963	1.035	.944	1.048	.962	1.027	.888	1.077
.975	1.020	.949	1.048	.976	1.023	.922	1.077	.976	1.017	.876	1.078
.945	1.057	.912	1.070	.946	1.056	.934	1.068	.915	1.060	?	?
.946	1.056	.851	1.124	.947	1.055	.938	1.063	.913	1.055	.880	1.081
.923	1.066	.835	1.143	.924	1.065	.938	1.059	.901	1.059	.852	1.088
.903	1.080	.898	1.090	.903	1.080			.911	1.062	.806	1.114
.943	1.062	.920	1.072	.944	1.061			.902	1.061	.869	1.083
.929	1.067	.958	1.040	.928	1.066	.959	1.041	.889	1.067	.913	1.060
.874	1.100	.974	1.026	.875	1.099	.957	1.041	.872	1.076	.962	1.028
.847	1.128	.898	1.040	.848	1.127	.953	1.043	.856	1.085	.866	1.089
.874	1.110	.904	1.090	.876	1.107	.945	1.047	.911	1.064	.865	1.085
.885	1.102	.850	1.126	.886	1.100	.926	1.073	.884	1.069	.848	1.093
.893	1.095	.835	1.144	.895	1.093	.937	1.065	.817	1.108	.861	1.093
.927	1.069			.927	1.068	.940	1.060	.904	1.066	.841	1.096
.952	1.047			.952	1.046	.940	1.057	.888	1.067	.802	1.118
.891	1.102	.931	1.068	.892	1.100			.865	1.077	.837	1.099
.903	1.095	.936	1.066	.904	1.094			.838	1.091	.891	1.073
.912	1.085	.915	1.073	.913	1.084	.966	1.034	.810	1.109	.953	1.034
.900	1.088	.897	1.086	.901	1.087	.963	1.035	.908	1.062	.833	1.105
.898	1.103	.915	1.077	.899	1.101	.958	1.038	.938	1.044	.847	1.097
.903	1.101	.865	1.110	.904	1.099	.950	1.042	.973	1.020	.842	1.098
.870	1.112	.868	1.120	.871	1.111	.939	1.011	.901	1.068	.831	1.109
.846	1.131	.884	1.111	.847	1.130	.946	1.056	.883	1.072	.824	1.107
		.903	1.094			.947	1.054	.855	1.087	.795	1.124
		.894	1.094			.945	1.052	.893	1.072	.785	1.122
.929	1.061	.886	1.116	.940	1.051			.860	1.082	.853	1.092
.880	1.095	.860	1.122	.895	1.080			.808	1.111	.937	1.046
.919	1.079			.931	1.066					.782	1.127
.877	1.105			.892	1.090					.817	1.113
										.832	1.107
										.779	1.131
										.793	1.125
										.785	1.134

TABLE Q_p-3

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for Belmont H.S., in some order as runs listed in BA tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule

TABLE BA-3		TABLE BA-4		TABLE BA-5		TABLE BA-6		TABLE BA-7		TABLE BA-8	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.862	1.087	.954	1.033	.933	1.047	.954	1.033	.926	1.052	.945	1.040
.892	1.072	.976	1.017	.938	1.044	.959	1.030	.932	1.048	.961	1.028
.925	1.053	.985	1.011	.958	1.031	.969	1.023	.938	1.044	.972	1.021
.973	1.020	.910	1.053	.972	1.020	.976	1.017	.957	1.031	.942	1.041
.846	1.090	.862	1.081	.934	1.047	.984	1.012	.972	1.020	.926	1.046
.848	1.095	.847	1.091	.835	1.046	.956	1.031	.983	1.012	.916	1.051
.848	1.095	.858	1.076	.921	1.049	.938	1.038	.934	1.048	.924	1.047
.837	1.100	.790	1.123	.927	1.050	.926	1.044	.934	1.047	.886	1.067
.832	1.106	.772	1.138	.916	1.052	.914	1.101	.921	1.049	.866	1.079
.813	1.113	.908	1.063	.879	1.071	.941	1.036	.910	1.054	.886	1.063
.780	1.134	.952	1.035	.858	1.084	.902	1.056	.903	1.058	.821	1.100
.842	1.097	.970	1.022	.901	1.057	.879	1.070	.927	1.051	.793	1.120
.877	1.082	.883	1.074	.876	1.069	.858	1.083	.915	1.053		
.914	1.060	.854	1.089	.814	1.105	.907	1.050	.879	1.072		
.829	1.108	.843	1.096	.785	1.127	.840	1.036	.857	1.084		
.836	1.103	.841	1.093	.866	1.086	.808	1.108	.844	1.093		
.840	1.101	.786	1.129	.878	1.081	.784	1.128	.926	1.052		
.815	1.115	.770	1.142	.894	1.069	.937	1.045	.900	1.058		
.805	1.119			.896	1.066	.952	1.035	.875	1.070		
.778	1.137			.857	1.090	.968	1.024	.813	1.106		
.816	1.109	.925	1.052	.844	1.094	.918	1.052	.784	1.128		
.855	1.091	.970	1.022	.803	1.117	.912	1.055	.768	1.141		
.899	1.069	.983	1.013	.780	1.133	.906	1.058	.847	1.094		
.806	1.120	.872	1.079			.886	1.069	.861	1.088		
.819	1.112	.843	1.095			.869	1.079	.873	1.083		
.829	1.108	.817	1.107	.899	1.068	.853	1.088	.915	1.060		
.794	1.127	.770	1.141	.900	1.063	.830	1.097	.944	1.041		
.794	1.127	.849	1.094	.834	1.097	.803	1.115	.864	1.088		
.774	1.140	.832	1.107	.788	1.126	.781	1.131	.877	1.083		
.781	1.125	.831	1.105					.893	1.070		
.826	1.106	.793	1.128					.896	1.066		
.878	1.080			.904	1.058	.880	1.078	.868	1.089		
.774	1.133					.880	1.078	.870	1.085		
.795	1.125							.859	1.089		
.814	1.118							.847	1.094		
								.847	1.094		
								.856	1.092		
								.842	1.096		
								.801	1.119		
								.778	1.134		

TABLE Q_p-4

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for Champaign-Urbana, in same order as runs listed in CUS tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule.

TABLE CUS-1 (a)		TABLE CUS-1 (b)		TABLE CUS-2 (a)		TABLE CUS-2 (b)		TABLE CUS-3 (a)		TABLE CUS-3 (b)	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.934	1.062	.927	1.069	.932	1.064	.891	1.096	.948	1.050	.892	1.096
.939	1.059	.932	1.065	.936	1.061	.902	1.087	.950	1.048	.903	1.087
.941	1.055	.937	1.060	.940	1.056	.911	1.080	.953	1.045	.912	1.080
.958	1.040	.955	1.043	.957	1.041	.943	1.053	.964	1.035	.944	1.053
.971	1.028	.968	1.031	.968	1.030	.965	1.034	.972	1.026	.965	1.033
.943	1.062	.936	1.067	.940	1.063	.911	1.090	.953	1.050	.912	1.091
.942	1.062	.937	1.067	.940	1.013	.914	1.089	.951	1.051	.915	1.088
.902	1.078	.898	1.082	.901	1.029	.880	1.097	.912	1.069	.880	1.097
.872	1.099	.872	1.100	.875	1.097	.856	1.114	.885	1.087	.856	1.114
.935	1.069	.935	1.074	.989	1.069	.904	1.099	.951	1.056	.905	1.099
.908	1.078	.902	1.083	.906	1.078	.876	1.106	.920	1.065	.877	1.105
.833	1.122	.827	1.127	.832	1.123	.808	1.147	.846	1.108	.808	1.147
.795	1.159	.796	1.159	.800	1.155	.779	1.179	.811	1.142	.778	1.179
.867	1.115	.853	1.126	.863	1.117	.793	1.170	.895	1.094	.791	1.170
.876	1.109	.863	1.119	.871	1.112	.812	1.158	.899	1.091	.810	1.157
.884	1.103	.874	1.111	.881	1.105	.827	1.147	.905	1.086	.827	1.146
.916	1.079	.910	1.083	.915	1.080	.888	1.101	.978	1.068	.888	1.101
.942	1.056	.936	1.062	.937	1.060	.930	1.067	.945	1.053	.930	1.066
.884	1.110	.870	1.120	.878	1.113	.827	1.156	.904	1.091	.826	1.156
.895	1.106	.887	1.135	.893	1.107	.847	1.146	.913	1.089	.848	1.145
.892	1.101	.888	1.106	.891	1.102	.868	1.126	.904	1.089	.868	1.125
.869	1.109	.869	1.111	.871	1.108	.852	1.125	.882	1.047	.852	1.125
.893	1.114	.881	1.123	.888	1.116	.841	1.159	.911	1.045	.842	1.158
.889	1.116	.882	1.124	.887	1.117	.848	1.155	.906	1.048	.849	1.154
.829	1.135	.873	1.141	.828	1.136	.804	1.163	.843	1.122	.803	1.162
.79[illegible]	1.163	.794	1.163	.799	1.159	.777	1.183	.809	1.146	.777	1.183
.923	1.060	.911	1.094	.914	1.089	.887	1.091	.930	1.073	.902	1.079
.860	1.096	.905	1.093	.909	1.089	.816	1.139	.923	1.075	.832	1.122
.916	1.078	.872	1.111	.876	1.106	.875	1.116	.893	1.090	.891	1.102
.857	1.108	.851	1.119	.856	1.114	.812	1.155	.872	1.099	.828	1.136
		.839	1.154	.847	1.146			.874	1.123		
		.855	1.146	.861	1.139			.883	1.119		
		.841	1.162	.848	1.155			.870	1.133		
		.834	1.160	.840	1.153			.859	1.134		

TABLE Q_p-5

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for Champaign-Urbana, in same order as runs listed in CUS & CUA tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule.

TABLE CUS-4		TABLE CUA-1		TABLE CUA-2(a)		TABLE CUA-2(b)		TABLE CUA-3(a)		TABLE CUA-3(b)	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.944	1.059	.932	1.074	.937	1.068	.894	1.103	.952	1.054	.896	1.103
.938	1.058	.936	1.070	.940	1.065	.907	1.094	.954	1.052	.908	1.094
.932	1.060	.942	1.065	.945	1.061	.916	1.087	.957	1.049	.917	1.087
.921	1.064	.959	1.048	.961	1.045	.948	1.058	.975	1.030	.948	1.058
.897	1.102	.971	1.035	.972	1.039	.968	1.037	.951	1.056	.968	1.037
.914	1.090	.933	1.074	.937	1.068	.901	1.101	.934	1.063	.901	1.100
.917	1.084	.916	1.081	.920	1.076	.888	1.105	.816	1.100	.889	1.104
.915	1.079	.840	1.101	.845	1.096	.818	1.117	.921	1.067	.818	1.117
		.798	1.113	.803	1.109	.778	1.126	.857	1.083	.777	1.126
		.900	1.087	.918	1.081	.855	1.118	.696	1.150	.855	1.117
.946	1.056	.831	1.104	.837	1.098	.801	1.130	.899	1.101	.800	1.129
.941	1.055	.717	1.144	.725	1.138	.697	1.158	.904	1.098	.696	1.162
.934	1.058	.677	1.167	.687	1.162	.659	1.185	.905	1.043	.658	1.185
.923	1.062	.853	1.134	.864	1.126	.781	1.177	.949	1.058	.774	1.175
.902	1.096	.863	1.128	.873	1.120	.803	1.166	.911	1.099	.801	1.164
.917	1.087	.876	1.120	.884	1.113	.822	1.155	.903	1.099	.821	1.153
.920	1.031	.916	1.090	.918	1.086	.891	1.109	.819	1.108	.892	1.109
.917	1.027	.940	1.067	.942	1.065	.934	1.072	.899	1.105	.935	1.072
		.876	1.127	.884	1.120	.823	1.165	.858	1.116	.822	1.164
		.873	1.127	.880	1.120	.830	1.161	.698	1.162	.830	1.160
.956	1.046	.838	1.129	.843	1.124	.814	1.149			.814	1.149
.949	1.048	.802	1.131	.807	1.128	.781	1.145			.780	1.144
.942	1.051	.866	1.135	.874	1.127	.818	1.174	.907	1.088	.817	1.172
.920	1.057	.828	1.143	.835	1.136	.792	1.176	.889	1.093	.790	1.175
.919	1.081	.720	1.165	.728	1.159	.700	1.185	.820	1.112	.699	1.184
.929	1.075	.679	1.178	.686	1.173	.661	1.193	.785	1.121	.660	1.193
.929	1.072							.859	1.137		
.924	1.070							.857	1.136		
		.883	1.110	.888	1.105	.827	1.111	.815	1.153	.845	1.097
		.867	1.113	.871	1.108	.706	1.155	.788	1.157	.725	1.139
		.792	1.136	.801	1.130	.823	1.142			.843	1.123
		.757	1.144	.768	1.138	.709	1.176			.727	1.159
		.819	1.169	.830	1.161			.861	1.085		
		.824	1.165	.833	1.158			.742	1.126		
		.780	1.184	.792	1.176			.860	1.110		
		.759	1.185	.770	1.178			.745	1.144		
		.846	1.096								
		.723	1.138								
		.844	1.123								
		.726	1.159								
		.875	1.095								
		.757	1.114								
		.876	1.097								
		.760	1.131								

TABLE Q_p-6

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for North High-Towson, in same order as runs listed in TNHS & NHA tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule.

TABLE TNHS-1		TABLE TNHS-2		TABLE TNHS-3		TABLE TNHS-4		TABLE NHA-1		TABLE NHA-2 (a)	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.951	1.048	.936	1.060	.964	1.035	.950	1.041	.963	1.060	.966	1.055
.954	1.046	.941	1.056	.916	1.034	.925	1.051	.965	1.056	.968	1.052
.956	1.041	.946	1.050	.967	1.030	.909	1.060	.968	1.052	.970	1.048
.968	1.029	.964	1.033	.974	1.023	.890	1.073	.977	1.037	.978	1.035
.977	1.020	.974	1.023	.980	1.017	.939	1.065	.983	1.027	.984	1.026
.953	1.054	.941	1.015	.965	1.040	.922	1.068	.951	1.069	.953	1.064
.928	1.062	.903	1.024	.935	1.048	.907	1.072	.914	1.088	.921	1.083
.836	1.105	.823	1.117	.857	1.088	.888	1.080	.814	1.148	.820	1.141
.799	1.135	.790	1.146	.816	1.119			.769	1.193	.775	1.186
.893	1.070	.875	1.083	.914	1.053			.876	1.096	.881	1.089
.826	1.075	.808	1.112	.853	1.077	.940	1.050	.793	1.134	.802	1.126
.720	1.175	.710	1.190	.746	1.150	.914	1.060	.676	1.236	.685	1.223
.681	1.221	.675	1.232	.702	1.197	.898	1.069	.634	1.307	.642	1.294
.899	1.143	.870	1.114	.928	1.068	.880	1.081	.923	1.113	.928	1.104
.905	1.138	.880	1.106	.931	1.065	.926	1.078	.928	1.107	.933	1.094
.914	1.132	.892	1.097	.935	1.062	.910	1.079	.934	1.099	.938	1.093
.938	1.159	.928	1.067	.950	1.047	.896	1.082	.954	1.073	.956	1.069
.955	1.043	.951	1.047	.962	1.036	.879	1.088	.967	1.054	.968	1.052
.915	1.043	.894	1.112	.938	1.069			.932	1.114	.936	1.107
.907	1.045	.890	1.112	.928	1.073			.907	1.127	.911	1.119
.834	1.118	.820	1.130	.855	1.049	.938	1.053	.822	1.165	.827	1.158
.798	1.141	.788	1.151	.816	1.124	.912	1.063	.774	1.200	.780	1.194
.886	1.107	.866	1.126	.910	1.082	.896	1.071	.881	1.137	.885	1.128
.822	1.123	.803	1.141	.850	1.098	.878	1.083	.801	1.166	.809	1.158
.719	1.182	.709	1.197	.746	1.157	.922	1.082	.680	1.247	.689	1.235
.683	1.223	.675	1.235	.702	1.200	.907	1.082	.637	1.311	.644	1.296
						.893	1.085				
						.876	1.091				
.889	1.087	.873	1.101	.909	1.069			.884	1.123	.888	1.116
.866	1.096	.849	1.109	.887	1.077			.858	1.135	.863	1.129
.787	1.129	.772	1.145	.815	1.105			.753	1.175	.763	1.165
.756	1.148	.742	1.164	.784	1.123			.717	1.199	.728	1.188
.872	1.131	.851	1.151	.898	1.103			.873	1.174	.878	1.165
.856	1.132	.838	1.149	.880	1.107			.854	1.181	.859	1.172
.781	1.160	.765	1.178	.811	1.132			.763	1.216	.773	1.204
.751	1.172	.738	1.190	.781	1.144			.725	1.233	.735	1.220

TABLE Q_p-7

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for North High-Towson, in same order as listed in NHA & TOA tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule.

TABLE NHA-2 (b)		TABLE NHA-3		TABLE TOA-1		TABLE TOA-2		TABLE TOA-3	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.952	1.073	.974	1.044	.947	1.043	.950	1.039	.962	1.031
.956	1.068	.976	1.042	.950	1.040	.053	1.037	.963	1.030
.961	1.062	.976	1.039	.953	1.036	.955	1.033	.964	1.027
.974	1.042	.981	1.030	.966	1.025	.968	1.024	.972	1.020
.981	1.029	.986	1.022	.976	1.018	.976	1.017	.979	1.015
.940	1.083	.985	1.051	.950	1.056	.953	1.053	.841	1.043
.898	1.104	.931	1.068	.693	1.069	.719	1.064	.739	1.054
.801	1.164	.837	1.122	.553	1.103	.570	1.097	.592	1.087
.760	1.208	.788	1.167	.890	1.082	.521	1.131	.538	1.120
.859	1.113	.898	1.073	.897	1.077	.544	1.078	.571	1.066
.777	1.153	.822	1.107	.906	1.072	.461	1.101	.484	1.087
.665	1.255	.702	1.199	.933	1.052	.896	1.076	.921	1.060
.628	1.324	.655	1.263	.952	1.038	.902	1.072	.925	1.058
.899	1.138	.946	1.083	.909	1.090	.910	1.067	.930	1.055
.907	1.130	.948	1.080	.686	1.098	.936	1.049	.946	1.042
.917	1.118	.952	1.025	.551	1.115	.954	1.037	.959	1.032
.947	1.083	.963	1.059	.508	1.131	.805	1.084	.833	1.068
.964	1.059	.973	1.046			.705	1.086	.734	1.077
.914	1.136	.949	1.087			.567	1.109	.590	1.098
.889	1.149	.927	1.098	.636	1.092	.520	1.126	.537	1.117
.808	1.183	.843	1.138	.595	1.099	.541	1.106	.568	1.089
.765	1.216	.793	1.174	.625	1.129	.459	1.121	.482	1.107
.861	1.162	.903	1.105	.587	1.130				
.785	1.190	.829	1.133						
.669	1.266	.705	1.210			.656	1.086	.683	1.074
.630	1.328	.657	1.267			.615	1.093	.639	1.081
						.424	1.124	.445	1.111
						.647	1.122	.416	1.126
.868	1.142	.905	1.096			.608	1.123	.677	1.105
.842	1.154	.880	1.109			.421	1.151	.635	1.108
.739	1.194	.783	1.143					.442	1.135
.705	1.219	.746	1.165					.414	1.143
.853	1.199	.897	1.138						
.837	1.204	.877	1.146						
.748	1.239	.791	1.177						
.713	1.253	.753	1.195						

TABLE Q_p-8

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for Royal Oak, in same order as runs listed in RS & RA tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule

TABLE RS-1		TABLE RS-2		TABLE RS-3		TABLE RA-1		TABLE RA-2		TABLE RA-3	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.941	1.057	.944	1.053	.958	1.041	.949	1.063	.952	1.058	.964	1.046
.954	1.043	.956	1.040	.964	1.033	.960	1.047	.962	1.044	.969	1.036
.962	1.034	.964	1.033	.970	1.027	.967	1.038	.968	1.036	.973	1.031
.968	1.029	.976	1.021	.974	1.024	.972	1.032	.979	1.023	.977	1.027
.976	1.021	.983	1.011	.979	1.019	.979	1.024	.987	1.014	.981	1.021
.911	1.066	.828	1.096	.928	1.052	.912	1.085	.822	1.122	.929	1.066
.876	1.079	.775	1.127	.894	1.065	.873	1.104	.768	1.159	.892	1.085
.855	1.089	.718	1.175	.872	1.076	.851	1.117	.707	1.212	.869	1.099
.831	1.104	.678	1.163	.847	1.092	.826	1.133	.668	1.192	.841	1.117
.820	1.102	.625	1.211	.848	1.082	.814	1.128	.609	1.245	.842	1.103
.767	1.133	.573	1.278	.789	1.112	.758	1.166	.554	1.318	.785	1.139
.789	1.154	.912	1.080	.764	1.133	.729	1.190	.900	1.111	.754	1.165
.761	1.180	.929	1.067	.731	1.162	.699	1.220	.924	1.088	.720	1.195
.665	1.171	.954	1.043	.699	1.144	.650	1.203	.938	1.073	.684	1.171
.614	1.221	.971	1.027	.642	1.192	.597	1.258	.960	1.048	.627	1.221
.590	1.252	.823	1.122	.615	1.222	.571	1.289	.975	1.030	.596	1.248
.566	1.287	.773	1.141	.586	1.259	.546	1.330	.821	1.150	.565	1.287
.879	1.110	.717	1.179	.913	1.080	.893	1.120	.767	1.179	.925	1.088
.908	1.085	.676	1.179	.929	1.066	.920	1.094	.707	1.224	.938	1.073
.926	1.070	.624	1.219	.940	1.056	.936	1.027	.664	1.213	.948	1.062
.938	1.059	.573	1.281	.948	1.049	.946	1.065	.610	1.261	.955	1.054
.953	1.045	.914	1.063	.959	1.039	.959	1.049	.556	1.330	.965	1.043
.901	1.100	.879	1.076	.921	1.080	.902	1.120	.915	1.080	.922	1.094
.871	1.102	.858	1.086	.890	1.084	.873	1.131	.877	1.099	.892	1.108
.852	1.106	.835	1.101	.870	1.090	.851	1.139	.855	1.113	.869	1.118
.830	1.113	.905	1.095	.845	1.099	.827	1.149	.830	1.129	.842	1.131
.816	1.128	.875	1.098	.844	1.104	.814	1.158	.906	1.113	.842	1.127
.764	1.147	.856	1.102	.792	1.125	.758	1.188	.876	1.125	.786	1.159
.738	1.168	.833	1.109	.763	1.141	.730	1.208	.855	1.134	.755	1.179
.710	1.184			.730	1.166	.700	1.232	.830	1.145	.720	1.206
.663	1.188			.697	1.160	.651	1.225			.685	1.188
.613	1.229			.642	1.199	.599	1.275			.628	1.234
.590	1.256			.615	1.225	.574	1.308			.599	1.264
.566	1.290			.586	1.261	.548	1.344			.568	1.298
.835	1.110			.863	1.088	.833	1.136			.861	1.107
.782	1.131			.810	1.109	.776	1.167			.804	1.137
.683	1.167			.718	1.139	.671	1.200			.705	1.167
.629	1.209			.662	1.180	.614	1.250			.645	1.211

TABLE Q_p-9

Ratio $Q_p/\overline{Q}_d = Q_p/Q_{pd}$ for L. A. County, in same order as runs listed in LACS & LACA tables; largest and smallest $Q_p/\overline{Q}_d$ for 24-hr. of demand schedule.

TABLE LACS-1		TABLE LACS-2		TABLE LACS-3		TABLE LACA-1		TABLE LACA-2		TABLE LACA-3	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.934	1.064	.937	1.059	.962	1.037	.932	1.063	.936	1.059	.961	1.037
.949	1.048	.950	1.045	.966	1.031	.948	1.048	.950	1.044	.966	1.030
.958	1.038	.960	1.037	.971	1.026	.958	1.038	.959	1.036	.970	1.026
.965	1.032	.966	1.031	.974	1.023	.964	1.032	.965	1.031	.974	1.023
.973	1.024	.974	1.023	.979	1.019	.973	1.024	.973	1.023	.979	1.018
.879	1.028	.883	1.074	.914	1.052	.886	1.083	.891	1.028	.920	1.055
.834	1.093	.839	1.089	.871	1.068	.855	1.101	.859	1.096	.889	1.073
.808	1.105	.814	1.101	.844	1.080	.836	1.112	.841	1.108	.869	1.085
.781	1.122	.786	1.118	.812	1.099	.815	1.126	.819	1.123	.843	1.102
.750	1.123	.762	1.117	.805	1.087	.795	1.129	.804	1.122	.845	1.090
.689	1.158	.701	1.151	.741	1.121	.744	1.164	.753	1.156	.791	1.125
.660	1.181	.670	1.174	.705	1.145	.718	1.184	.726	1.177	.760	1.147
.631	1.211	.639	1.204	.667	1.176	.690	1.209	.698	1.202	.725	1.175
.556	1.208	.571	1.198	.610	1.162	.637	1.211	.650	1.202	.691	1.163
.506	1.255	.519	1.244	.553	1.209	.587	1.260	.600	1.250	.633	1.210
.488	1.282	.493	1.270	.521	1.232	.564	1.289	.574	1.278	.604	1.238
.460	1.317	.468	1.306	.489	1.265	.540	1.322	.548	1.312	.573	1.275
.868	1.121	.873	1.113	.922	1.073	.861	1.120	.871	1.111	.920	1.073
.897	1.095	.902	1.089	.939	1.062	.896	1.094	.900	1.089	.933	1.061
.917	1.078	.920	1.074	.943	1.054	.916	1.077	.919	1.073	.942	1.054
.931	1.066	.933	1.063	.950	1.048	.930	1.065	.932	1.062	.949	1.047
.948	1.050	.949	1.048	.959	1.039	.947	1.049	.948	1.048	.959	1.039
.908	1.115	.877	1.109	.910	1.079	.860	1.118	.865	1.112	.902	1.079
.829	1.118	.835	1.113	.869	1.086	.837	1.128	.842	1.122	.876	1.092
.805	1.123	.811	1.118	.842	1.094	.823	1.133	.828	1.129	.858	1.102
.779	1.131	.785	1.127	.811	1.107	.806	1.142	.811	1.138	.836	1.115
.746	1.151	.758	1.143	.802	1.108	.777	1.159	.788	1.150	.832	1.112
.687	1.174	.699	1.166	.739	1.133	.733	1.185	.744	1.176	.783	1.141
.659	1.191	.669	1.184	.705	1.153	.710	1.201	.719	1.193	.754	1.160
.630	1.215	.638	1.208	.667	1.180	.686	1.220	.698	1.214	.721	1.185
.555	1.224	.570	1.214	.610	1.174	.630	1.233	.644	1.220	.686	1.178
.508	1.269	.520	1.258	.553	1.217	.584	1.275	.595	1.263	.631	1.221
.486	1.296	.496	1.289	.524	1.243	.561	1.300	.572	1.288	.602	1.247
.462	1.327	.470	1.315	.491	1.272	.539	1.330	.547	1.318	.571	1.281
.888	1.098	.893	1.092	.923	1.065	.878	1.100	.883	1.093	.917	1.065
.820	1.110	.826	1.105	.858	1.081	.837	1.119	.842	1.114	.873	1.088
.769	1.131	.780	1.124	.824	1.091	.800	1.137	.810	1.130	.853	1.094
.675	1.175	.686	1.167	.724	1.136	.726	1.183	.736	1.175	.773	1.142
.574	1.203	.589	1.192	.630	1.155	.651	1.209	.665	1.198	.708	1.158
.498	1.276	.509	1.264	.540	1.226	.575	1.280	.585	1.269	.618	1.227

APPENDIX IV

TABLES OF ALL COMPUTER RUN RESULTS, VARIABLE SUCTION

APPENDIX IV

TABLES OF ALL COMPUTER RUN RESULTS, VARIABLE SUCTION

Demand Schedule	Table	a_s, ft.	N_s	$\overline{Q_d}$, mgd	E_{pd}, ft.
$a/\overline{Q_d} = 0.353$	BSVS-1	2.5	2200	20	243.3
				10	153.3
(20%, only)	BSVS-2	2.5	3000	20	219.1
				10	138.0
	BSVS-3	2.5	4000	20	191.9
				10	120.9
	BSVS-4	5.0	2200	20	243.3
				10	153.3
	BSVS-5	5.0	3000	20	219.1
				10	138.0
	BSVS-6	5.0	4000	20	191.9
				10	120.9
$a/\overline{Q_d} = 0.766$	RSVS-1	2.5	2200	20	243.3
				10	153.3
(40%, only)	RSVS-2	2.5	3000	20	219.1
				10	138.0
	RSVS-3	2.5	4000	20	191.9
				10	120.9
	RSVS-4	5.0	2200	20	243.3
				10	153.3
	RSVS-5	5.0	3000	20	219.1
				10	138.0
	RSVS-6	5.0	4000	20	191.9
				10	120.9

Tables of $Q_p/\overline{Q_d}$, Addenda to Preceding Data

Tables	Demand Schedule
Q_p-VS1	$a/\overline{Q_d} = 0.353$
Q_p-VS2	$a/\overline{Q_d} = 0.766$

TABLE BSVS-1

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.353$

Specific Speed : $N_s = 2,200$ $N = 1,150$ rpm

Variable Suction, $a_s = 2.5$ ft.

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
			($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 ft.)							
4 (20%) ($\hat{y}$ = 7.0')	2	0	250.1	-6.8	0	0	.1107	0.2	.3135	
		0.05	230.3	13.0	20	0.082	.1118	20.0	.3166	
		0.10	210.4	32.9	40	0.164	.1121	39.9	.3176	
		0.15	190.4	52.9	60	0.247	.1122	59.9	.3179	
		0.25	150.5	92.8	100	0.411	.1124	99.8	.3185	
	2.5	0.05	229.5	13.8	20	0.082	.1054	20.8	.2985	
		0.10	209.0	34.3	40	0.164	.1021	41.3	.2893	
		0.15	188.6	54.7	60	0.247	.0999	61.7	.2831	
		0.25	147.9	95.4	100	0.411	.0972	102.4	.2755	
	3	0.05	228.6	14.7	20	0.082	.0996	21.7	.2821	
		0.10	207.5	35.8	40	0.164	.0934	42.8	.2647	
		0.15	186.7	56.5	60	0.247	.0898	63.5	.2545	
		0.25	145.5	97.8	100	0.411	.0855	104.8	.2423	
	4	0.05	226.4	16.8	20	0.082	.0891	23.9	.2523	
		0.10	204.6	38.6	40	0.164	.0798	45.7	.2259	
		0.15	183.3	59.9	60	0.247	.0745	66.9	.2110	
		0.25	141.5	101.8	100	0.411	.0689	108.8	.1951	
			($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 ft.)							
2 (20%) ($\hat{y}$ = 7.0')	2.5	0.10	149.6	3.7	10	0.065	.1050	10.7	.2974	
		0.20	139.3	14.0	20	0.131	.1024	21.0	.2902	
		0.30	129.0	24.2	30	0.196	.1006	31.3	.2849	
	3	0.10	149.0	4.3	10	0.065	.1002	11.3	.2839	
		0.20	138.3	14.9	20	0.131	.0951	21.9	.2694	
		0.30	127.8	25.5	30	0.196	.0915	32.5	.2592	
	4	0.10	147.7	5.6	10	0.065	.0913	12.6	.2585	
		0.20	136.4	16.9	20	0.131	.0825	23.9	.2337	
		0.30	125.5	27.7	30	0.196	.0772	34.7	.2187	

TABLE BSVS-2

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.353$

Specific Speed : $N_s = 3{,}000$ $N = 1{,}450$ rpm

Variable Suction, $a_s = 2.5$ ft.

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 ft.)						
4	2	0	225.9	-6.8	0	0	.1109	0.2	.3142	
(20%)		0.05	206.1	13.0	20	0.091	.1118	20.0	.3167	
		0.10	186.2	32.9	40	0.183	.1121	40.0	.3175	
($\hat{y}$ =		0.15	166.3	52.9	60	0.274	.1123	59.9	.3181	
7.0')		0.25	126.4	92.8	100	0.456	.1125	99.8	.3187	
	2.5	0.05	205.4	13.8	20	0.091	.1058	20.8	.2997	
		0.10	184.8	34.3	40	0.183	.1025	41.3	.2903	
		0.15	164.4	54.7	60	0.274	.1003	61.8	.2841	
		0.25	123.7	95.4	100	0.456	.0977	102.4	.2767	
	3	0.05	204.4	14.8	20	0.091	.1001	21.8	.2836	
		0.10	183.3	35.8	40	0.183	.0942	42.9	.2668	
		0.15	162.5	56.7	60	0.274	.0904	63.7	.2562	
		0.25	121.2	97.9	100	0.456	.0862	104.9	.2441	
	4	0.05	202.2	16.9	20	0.091	.0901	23.9	.2552	
		0.10	180.2	38.9	40	0.183	.0807	45.9	.2287	
		0.15	158.9	60.2	60	0.274	.0755	67.2	.2139	
		0.25	117.0	102.2	100	0.456	.0696	109.2	.1972	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 ft.)						
2	2.5	0.10	134.4	3.7	10	0.072	.1055	10.7	.2987	
(20%)		0.20	124.1	14.0	20	0.145	.1029	21.0	.2916	
		0.30	113.8	24.2	30	0.217	.1011	31.2	.2864	
($\hat{y}$ =	3	0.10	133.8	4.3	10	0.072	.1009	11.3	.2860	
7.0')		0.20	123.1	15.0	20	0.145	.0957	22.0	.2710	
		0.30	112.6	25.5	30	0.217	.0923	32.5	.2614	
	4	0.10	132.4	5.6	10	0.072	.0923	12.7	.2615	
		0.20	121.1	17.0	20	0.145	.0836	24.0	.2367	
		0.30	110.2	27.9	30	0.217	.0783	34.9	.2217	

TABLE BSVS-3

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.353$

Specific Speed : $N_s = 4,000$ $N = 1,750$ rpm

Variable Suction, $a_s = 2.5$ ft.

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
				(Q_d = 20 mgd; E_{pd} = 191.9 ft.)						
4	2	0	198.7	-6.8	0	0	.1115	0.2	.3158	
(20%)		0.05	179.0	12.9	20	0.104	.1122	19.9	.3177	
		0.10	159.0	32.9	40	0.208	.1122	39.9	.3180	
($\hat{y}$ =		0.15	139.1	52.8	60	0.313	.1124	59.8	.3184	
7.0')		0.25	99.2	92.7	100	0.521	.1126	99.7	.3189	
	2.5	0.05	178.2	13.7	20	0.104	.1071	20.7	.3034	
		0.10	157.7	34.2	40	0.208	.1040	41.2	.2946	
		0.15	137.2	54.6	60	0.313	.1019	61.7	.2886	
		0.25	96.6	95.3	100	0.521	.0991	102.3	.2807	
	3	0.05	177.3	14.6	20	0.104	.1024	21.6	.2900	
		0.10	156.1	35.7	40	0.208	.0967	42.8	.2739	
		0.15	135.3	56.6	60	0.313	.0929	63.6	.2633	
		0.25	93.9	97.9	100	0.521	.0884	105.0	.2503	
	4	0.05	175.0	16.9	20	0.104	.0934	23.9	.2647	
		0.10	152.8	39.0	40	0.208	.0843	46.1	.2388	
		0.15	131.4	60.5	60	0.313	.0789	67.5	.2234	
		0.25	89.2	102.7	100	0.521	.0725	109.7	.2053	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 ft.)						
2	2.5	0.10	117.3	3.6	10	0.083	.1070	10.6	.3031	
(20%)		0.20	107.0	13.8	20	0.165	.1046	20.9	.2963	
		0.30	96.8	24.1	30	0.248	.1028	31.1	.2912	
($\hat{y}$ =	3	0.10	116.8	4.1	10	0.083	.1032	11.1	.2922	
7.0')		0.20	106.0	14.8	20	0.165	.0982	21.9	.2782	
		0.30	95.5	25.3	30	0.248	.0949	32.4	.2687	
	4	0.10	115.4	5.5	10	0.083	.0956	12.5	.2708	
		0.20	104.0	16.9	20	0.165	.0872	23.9	.2471	
		0.30	93.0	27.9	30	0.248	.0818	34.9	.2318	

TABLE BSVS-4

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/Q_d = 0.353$

Specific Speed : $N_s = 2,200$ $N = 1,150$ rpm

Variable Suction, $a_s = 5.0$ ft.

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q}_d^{-2}$	$\phi\overline{Q}_d^{-2} E_{pd}$	$U/\overline{Q}_d$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
				($\overline{Q}_d$ = 20 mgd; E_{pd} = 243.3 ft.)						
4	2	0	250.2	-6.9	0	0	.1116	0.1	.3161	
(20%)		0.05	230.4	12.9	20	0.082	.1123	19.9	.3182	
		0.10	210.4	32.8	40	0.164	.1125	39.9	.3186	
($\hat{y}$ =		0.15	190.4	52.8	60	0.247	.1125	59.9	.3186	
7.0')		0.25	150.5	92.8	100	0.411	.1126	99.8	.3189	
	2.5	0.05	229.5	13.7	20	0.082	.1058	20.7	.2998	
		0.10	209.0	34.2	40	0.164	.1024	41.2	.2901	
		0.15	188.6	54.6	60	0.247	.1001	61.7	.2837	
		0.25	147.9	95.4	100	0.411	.0974	102.4	.2758	
	3	0.05	228.6	14.6	20	0.082	.1000	21.7	.2833	
		0.10	207.5	35.8	40	0.164	.0937	42.8	.2654	
		0.15	186.8	56.5	60	0.247	.0900	63.5	.2550	
		0.25	145.5	97.8	100	0.411	.0856	104.8	.2425	
	4	0.05	226.5	16.8	20	0.082	.0894	23.8	.2532	
		0.10	204.6	38.6	40	0.164	.0799	45.7	.2264	
		0.15	183.3	59.9	60	0.247	.0746	66.9	.2113	
		0.25	141.5	101.8	100	0.411	.0689	108.8	.1952	
				($\overline{Q}_d$ = 10 mgd; E_{pd} = 153.3 ft.)						
2	2.5	0.10	149.7	3.6	10	0.065	.1063	10.6	.3011	
(20%)		0.20	139.3	13.9	20	0.131	.1033	20.9	.2925	
		0.30	129.1	24.2	30	0.196	.1012	31.2	.2868	
($\hat{y}$ =	3	0.10	149.1	4.2	10	0.065	.1014	11.2	.2872	
7.0')		0.20	138.4	14.8	20	0.131	.0958	21.9	.2715	
		0.30	127.8	25.4	30	0.196	.0920	32.4	.2607	
	4	0.10	147.7	5.5	10	0.065	.0922	12.5	.2613	
		0.20	136.4	16.8	20	0.131	.0830	23.9	.2352	
		0.30	125.5	27.7	30	0.196	.0776	34.7	.2197	

TABLE BSVS-5

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.353$

Specific Speed : $N_s = 3,000$ N = 1,450 rpm

Variable Suction, $a_s = 5.0$ ft.

V, mg	n	Φ	Y, Ft.	$E_{pd} - Y$, Ft.	$\Phi\overline{Q_d}^2$	$\Phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 ft.)										
4	2	0	226.0	-6.9	0	0	.1117	0.1	.3164	
(20%)		0.05	206.2	12.9	20	0.091	.1123	19.9	.3181	
		0.10	186.3	32.9	40	0.183	.1124	39.9	.3184	
($\hat{y}$ =		0.15	166.3	52.8	60	0.274	.1125	59.8	.3188	
7.0')		0.25	126.4	92.7	100	0.456	.1126	99.8	.3191	
	2.5	0.05	205.4	13.7	20	0.091	.1062	20.7	.3009	
		0.10	184.9	34.3	40	0.183	.1027	41.3	.2910	
		0.15	164.4	54.7	60	0.274	.1005	61.7	.2846	
		0.25	123.7	95.4	100	0.456	.0978	102.4	.2769	
	3	0.05	204.4	14.7	20	0.091	.1005	21.7	.2846	
		0.10	183.3	35.8	40	0.183	.0944	42.8	.2674	
		0.15	162.5	56.7	60	0.274	.0906	63.7	.2567	
		0.25	121.2	97.9	100	0.456	.0862	104.9	.2443	
	4	0.05	202.2	16.9	20	0.091	.0904	23.9	.2560	
		0.10	180.2	38.9	40	0.183	.0809	45.9	.2291	
		0.15	158.9	60.2	60	0.274	.0756	67.2	.2141	
		0.25	117.0	102.2	100	0.456	.0697	109.2	.1973	
($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 ft.)										
2	2.5	0.10	134.5	3.5	10	0.072	.1067	10.6	.3022	
(20%)		0.20	124.2	13.9	20	0.145	.1038	20.9	.2940	
		0.30	113.9	24.1	30	0.217	.1017	31.2	.2880	
($\hat{y}$ =	3	0.10	133.9	4.1	10	0.072	.1020	11.2	.2890	
7.0')		0.20	123.1	14.9	20	0.145	.0963	21.9	.2728	
		0.30	112.6	25.4	30	0.217	.0927	32.5	.2626	
	4	0.10	132.5	5.5	10	0.072	.0932	12.6	.2639	
		0.20	121.1	16.9	20	0.145	.0841	23.9	.2381	
		0.30	110.2	27.8	30	0.217	.0786	34.9	.2226	

TABLE BSVS-6

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.353$

Specific Speed : $N_s = 4,000$ $N = 1,750$ rpm

Variable Suction, $a_s = 5.0$ ft.

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 ft.)						
4	2	0	198.8	-6.9	0	0	.1119	0.1	.3171	
(20%)		0.05	179.0	12.9	20	0.104	.1125	19.9	.3186	
		0.10	159.0	32.8	40	0.208	.1125	39.9	.3187	
($\hat{y}$ =		0.15	139.1	52.8	60	0.313	.1126	59.8	.3189	
7.0')		0.25	99.2	92.7	100	0.521	.1127	99.7	.3192	
	2.5	0.05	178.2	13.6	20	0.104	.1074	20.7	.3041	
		0.10	157.7	34.2	40	0.208	.1042	41.2	.2952	
		0.15	137.3	54.6	60	0.313	.1020	61.6	.2889	
		0.25	96.6	95.3	100	0.521	.0992	102.3	.2809	
	3	0.05	177.3	14.6	20	0.104	.1026	21.6	.2907	
		0.10	156.2	35.7	40	0.208	.0968	42.7	.2743	
		0.15	135.3	56.6	60	0.313	.0930	63.6	.2636	
		0.25	93.9	97.9	100	0.521	.0884	105.0	.2505	
	4	0.05	175.0	16.9	20	0.104	.0936	23.9	.2652	
		0.10	152.9	39.0	40	0.208	.0845	46.0	.2394	
		0.15	131.4	60.5	60	0.313	.0790	67.5	.2237	
		0.25	89.2	102.7	100	0.521	.0725	109.7	.2054	
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 ft.)						
2	2.5	0.10	117.5	3.4	10	0.083	.1080	10.4	.3060	
(20%)		0.20	107.1	13.8	20	0.165	.1052	20.8	.2979	
		0.30	96.8	24.0	30	0.248	.1032	31.1	.2924	
($\hat{y}$ =	3	0.10	116.8	4.0	10	0.083	.1039	11.0	.2943	
7.0')		0.20	106.1	14.8	20	0.165	.0987	21.8	.2796	
		0.30	95.6	25.3	30	0.248	.0952	32.3	.2697	
	4	0.10	115.4	5.4	10	0.083	.0962	12.5	.2725	
		0.20	104.0	16.9	20	0.165	.0876	23.9	.2482	
		0.30	93.0	27.9	30	0.248	.0821	34.9	.2326	

TABLE RSVS-1

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q}_d = 0.766$

Specific Speed : $N_s = 2{,}200$ $N = 1{,}150$ rpm

Variable Suction, $a_s = 2.5$ ft.

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q}_d^2$	$\phi\overline{Q}_d^2/E_{pd}$	$U/\overline{Q}_d$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q}_d$ = 20 mgd; E_{pd} = 243.3 ft.)						
8	2	0	250.7	-7.5	0	0	.2429	0.2	.3171	
(40%)		0.05	231.1	12.2	20	0.082	.2441	19.8	.3187	
		0.10	211.2	32.1	40	0.164	.2443	39.7	.3189	
($\hat{y}$ =		0.15	191.2	52.0	60	0.247	.2444	59.7	.3191	
7.6')		0.25	151.4	91.9	100	0.411	.2445	99.5	.3192	
	2.5	0.05	227.8	15.5	20	0.082	.2265	23.1	.2957	
		0.10	205.4	37.9	40	0.164	.2175	45.5	.2839	
		0.15	183.4	59.9	60	0.247	.2120	67.5	.2767	
		0.25	139.7	103.5	100	0.411	.2054	111.2	.2682	
	3.	0.05	223.1	20.2	20	0.082	.2081	27.8	.2717	
		0.10	198.4	44.9	40	0.164	.1932	52.5	.2523	
		0.15	174.6	68.7	60	0.247	.1847	76.3	.2412	
		0.25	128.1	115.2	100	0.411	.1753	122.8	.2288	
	4	0.05	212.0	31.3	20	0.082	.1744	38.9	.2277	
		0.10	184.1	59.2	40	0.164	.1554	66.8	.2029	
		0.15	158.4	84.9	60	0.247	.1455	92.5	.1900	0.2'*
		0.25	109.7	133.6	100	0.411	.1356	141.2	.1770	0.2'*
				($\overline{Q}_d$ = 10 mgd; E_{pd} = 153.3 ft.)						
4	2.5	0.10	149.0	4.2	10	0.065	.2284	11.9	.2982	
(40%)		0.20	137.7	15.6	20	0.131	.2201	23.2	.2874	
		0.30	126.5	26.7	30	0.196	.2148	34.4	.2804	
($\hat{y}$ =	3	0.10	146.3	6.9	10	0.065	.2123	14.6	.2772	
7.6')		0.20	133.6	19.7	20	0.131	.1980	27.3	.2585	
		0.30	121.4	31.9	30	0.196	.1893	39.5	.2471	
	4	0.10	139.6	13.6	10	0.065	.1811	21.3	.2364	
		0.20	124.9	28.4	20	0.131	.1618	36.0	.2112	
		0.30	111.6	41.6	30	0.196	.1515	49.2	.1978	
				($\overline{Q}_d$ = 20 mgd; E_{pd} = 243.3 ft.)						
4	3	0.20	156.5	86.8	80	0.329	.1786	102.0	.2331	
(20%)		0.30	110.1	133.2	120	0.493	.1718	148.4	.2243	
	4	0.10	188.9	54.4	40	0.164	.1557	69.6	.2033	
($\hat{y}$ =		0.20	137.4	105.9	80	0.329	.1391	121.1	.1816	
15.2')		0.30	87.9	155.3	120	0.493	.1313	170.6	.1714	

(*: approximate run).

TABLE RSVS-2

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.766$

Specific Speed : $N_s = 3{,}000$ $N = 1{,}450$ rpm

Variable Suction, $a_s = 2.5$ ft.

V, mg	n	Φ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 ft.)						
8 (40%)	2	0	226.6	-7.4	0	0	.2430	0.2	.3172	
		0.05	206.9	12.3	20	0.091	.2441	19.9	.3186	
($\hat{y}$ = 7.6')		0.10	187.0	32.1	40	0.183	.2443	39.8	.3189	
		0.15	167.1	52.1	60	0.274	.2444	59.7	.3191	
		0.25	127.2	91.9	100	0.456	.2445	99.5	.3192	
	2.5	0.05	203.5	15.6	20	0.091	.2273	23.2	.2967	
		0.10	181.1	38.1	40	0.183	.2184	45.7	.2852	
		0.15	159.0	60.1	60	0.274	.2130	67.7	.2781	
		0.25	115.3	103.9	100	0.456	.2063	111.5	.2694	
	3	0.05	198.7	20.4	20	0.091	.2098	28.0	.2738	
		0.10	174.0	45.2	40	0.183	.1953	52.8	.2549	
		0.15	150.2	69.0	60	0.274	.1867	76.6	.2438	
		0.25	103.8	115.3	100	0.456	.1771	123.0	.2312	
	4	0.05	187.5	31.6	20	0.091	.1775	39.3	.2317	
		0.10	159.4	59.7	40	0.183	.1588	67.4	.2073	
		0.15	133.3	85.9	60	0.274	.1486	93.5	.1940	
		0.25	84.3	134.8	100	0.456	.1383	142.4	.1805	0.2'*
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 ft.)						
4 (40%)	2.5	0.10	133.8	4.3	10	0.072	.2293	11.9	.2993	
		0.20	122.4	15.7	20	0.145	.2213	23.3	.2888	
		0.30	111.2	26.8	30	0.217	.2159	34.4	.2819	
($\hat{y}$ = 7.6')	3	0.10	130.9	7.1	10	0.072	.2137	14.7	.2790	
		0.20	118.2	19.9	20	0.145	.1999	27.5	.2609	
		0.30	106.0	32.0	30	0.217	.1913	39.7	.2498	
	4	0.10	124.3	13.7	10	0.072	.1842	21.3	.2405	
		0.20	109.4	28.7	20	0.145	.1650	36.3	.2155	
		0.30	95.8	42.2	30	0.217	.1544	49.8	.2016	
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 ft.)						
4 (20%)	3	0.20	132.0	87.2	80	0.365	.1803	102.4	.2354	
		0.30	85.6	133.5	120	0.548	.1734	148.8	.2264	
	4	0.10	163.9	55.2	40	0.183	.1587	70.4	.2071	
($\hat{y}$ = 15.2')		0.20	111.9	107.2	80	0.365	.1418	122.5	.1851	
		0.30	62.1	157.0	120	0.548	.1336	172.3	.1744	

(*: approximate run).

TABLE RSVS-3

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.766$

Specific Speed : $N_s = 4{,}000$ N = 1,750 rpm

Variable Suction, $a_s = 2.5$ ft.

V, mg	n	Φ	Y, Ft.	$E_{pd} - Y$, Ft.	$\Phi\overline{Q_d}^2$	$\Phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + y$	U/a	Y-FSTE
($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 ft.)										
8	2	0	199.3	-7.5	0	0	.2433	0.2	.3177	
(40%)		0.05	179.7	12.1	20	0.104	.2443	19.7	.3190	
		0.10	159.8	32.0	40	0.208	.2444	39.7	.3191	
($\hat{y}$ =		0.15	139.9	52.0	60	0.313	.2444	59.6	.3191	
7.6')		0.25	100.0	91.8	100	0.521	.2445	99.5	.3192	
	2.5	0.05	176.4	15.5	20	0.104	.2302	23.1	.3006	
		0.10	153.8	38.1	40	0.208	.2221	45.7	.2899	
		0.15	131.6	60.3	60	0.313	.2165	67.9	.2827	
		0.25	87.8	104.1	100	0.521	.2097	111.7	.2737	
	3	0.05	171.2	20.7	20	0.104	.2148	28.3	.2804	
		0.10	145.9	46.0	40	0.208	.2006	53.6	.2619	
		0.15	121.7	70.2	60	0.313	.1919	77.8	.2505	
		0.25	74.6	117.2	100	0.521	.1816	124.9	.2371	
	4	0.05	158.2	33.7	20	0.104	.1844	41.3	.2407	
		0.10	129.0	62.9	40	0.208	.1654	70.5	.2159	
		0.15	102.1	89.8	60	0.313	.1546	97.4	.2018	
		0.25	52.3	139.5	100	0.521	.1439	147.2	.1878	0.2'*
($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 ft.)										
4	2.5	0.10	116.7	4.2	10	0.083	.2320	11.8	.3029	
(40%)		0.20	105.3	15.6	20	0.165	.2247	23.2	.2934	
		0.30	94.1	26.8	30	0.248	.2196	34.4	.2867	
($\acute{y}$ =	3	0.10	113.8	7.1	10	0.083	.2187	14.7	.2855	
7.6')		0.20	100.7	20.2	20	0.165	.2054	27.8	.2681	
		0.30	88.3	32.6	30	0.248	.1968	40.2	.2569	
	4	0.10	106.1	14.8	10	0.083	.1905	22.4	.2487	
		0.20	90.5	30.3	20	0.165	.1718	38.0	.2243	
		0.30	76.5	44.4	30	0.248	.1607	52.0	.2098	
($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 ft.)										
4	3	0.30	56.6	135.3	120	0.625	.1776	150.5	.2319	
(20%)	4	0.10	133.8	58.0	40	0.208	.1652	73.3	.2157	
($\hat{y}$ =		0.20	80.2	111.7	80	0.417	.1476	126.9	.1926	
15.2')		0.30	29.4	162.5	120	0.625	.1387	177.7	.1811	

(*: approximate run).

TABLE RSVS-4

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d} = 0.766$

Specific Speed : $N_s = 2,200$ $N = 1,150$ rpm

Variable Suction, $a_s = 5.0$ ft.

V, mg	n	ϕ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + \hat{y}$	U/a	Y-FSTE
($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 ft.)										
8	2	0	250.8	-7.5	0	0	.2434	0.1	.3177	
(40%)		0.05	231.1	12.2	20	0.082	.2444	19.8	.3190	
		0.10	211.2	32.1	40	0.164	.2445	39.7	.3192	
($\hat{y}$ =		0.15	191.3	52.0	60	0.247	.2445	59.6	.3193	
7.6')		0.25	151.4	91.9	100	0.411	.2446	99.5	.3193	
	2.5	0.05	227.8	15.5	20	0.082	.2267	23.1	.2960	
		0.10	205.4	37.9	40	0.164	.2176	45.5	.2841	
		0.15	183.4	59.9	60	0.247	.2120	67.5	.2768	
		0.25	139.7	103.5	100	0.411	.2055	111.1	.2683	
	3	0.05	223.1	20.2	20	0.082	.2083	27.8	.2719	
		0.10	198.4	44.9	40	0.164	.1933	52.5	.2524	
		0.15	174.6	68.7	60	0.247	.1848	76.3	.2413	
		0.25	128.1	115.2	100	0.411	.1753	122.8	.2288	
	4	0.05	212.0	31.3	20	0.082	.1743	38.9	.2275	
		0.10	185.1	58.1	40	0.164	.1567	65.8	.2045	0.2'*
		0.15	160.8	82.5	60	0.247	.1482	90.1	.1934	0.4'*
		0.25	112.1	131.1	100	0.411	.1375	138.8	.1795	0.4'*
($\overline{Q_d}$ = 10 mgd; E_{pd} = 153.3 ft.)										
4	2.5	0.10	149.1	4.2	10	0.065	.2290	11.8	.2990	
(40%)		0.20	137.7	15.6	20	0.131	.2205	23.2	.2879	
		0.30	126.5	26.7	30	0.196	.2150	34.3	.2807	
($\hat{y}$ =	3	0.10	146.4	6.9	10	0.065	.2128	14.5	.2778	
7.6')		0.20	133.6	19.7	20	0.131	.1983	27.3	.2589	
		0.30	121.4	31.9	30	0.196	.1895	39.5	.2474	
	4	0.10	139.6	13.6	10	0.065	.1809	21.2	.2362	
		0.20	124.9	28.4	20	0.131	.1614	36.0	.2107	
		0.30	112.6	40.7	30	0.196	.1532	48.3	.1999	0.4'*
($\overline{Q_d}$ = 20 mgd; E_{pd} = 243.3 ft.)										
4	3	0.20	156.5	86.8	80	0.329	.1787	102.0	.2332	
(20%)		0.30	110.1	133.2	120	0.493	.1718	148.4	.2243	
	4	0.10	188.9	54.4	40	0.164	.1555	69.6	.2030	
($\hat{y}$ =		0.20	137.4	105.9	80	0.329	.1390	121.1	.1814	
15.2')		0.30	88.4	154.9	120	0.493	.1315	170.1	.1717	0.2'*

(*: approximate run).

TABLE RSVS-5

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/Q_d = 0.766$

Specific Speed : $N_s = 3{,}000$ N = 1,450 rpm

Variable Suction, $a_s = 5.0$ ft.

V, mg	n	φ	Y, Ft.	$E_{pd} - Y$, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	$E_{pd} - Y + y$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 ft.)						
8	2	0	226.7	-7.5	0	0	.2434	0.1	.3178	
(40%)		0.05	206.9	12.2	20	0.091	.2443	19.8	.3189	
		0.10	187.1	32.1	40	0.183	.2445	39.7	.3192	
($\dot{y}$ =		0.15	167.1	52.0	60	0.274	.2445	59.6	.3192	
7.6')		0.25	127.3	91.9	100	0.456	.2446	99.5	.3193	
	2.5	0.05	203.6	15.5	20	0.091	.2275	23.2	.2970	
		0.10	181.1	38.0	40	0.183	.2186	45.7	.2853	
		0.15	159.0	60.1	60	0.274	.2131	67.7	.2782	
		0.25	115.3	103.8	100	0.456	.2064	111.5	.2694	
	3	0.05	198.7	20.4	20	0.091	.2099	28.0	.2741	
		0.10	174.0	45.1	40	0.183	.1954	52.8	.2551	
		0.15	150.2	69.0	60	0.274	.1868	76.6	.2438	
		0.25	103.8	115.3	100	0.456	.1772	123.0	.2313	
	4	0.05	187.5	31.7	20	0.091	.1774	39.3	.2316	
		0.10	159.8	59.4	40	0.183	.1591	67.0	.2077	0.2'*
		0.15	135.5	83.7	60	0.274	.1508	91.3	.1968	0.4'*
		0.25	86.8	132.4	100	0.456	.1401	140.0	.1829	0.4'*
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 138.0 ft.)						
4	2.5	0.10	133.9	4.2	10	0.072	.2298	11.8	.3001	
(40%)		0.20	122.5	15.6	20	0.145	.2216	23.2	.2893	
		0.30	111.3	26.8	30	0.217	.2162	34.4	.2822	
($\hat{y}$ =	3	0.10	131.0	7.0	10	0.072	.2142	14.7	.2796	
7.6')		0.20	118.2	19.8	20	0.145	.2002	27.5	.2613	
		0.30	106.0	32.0	30	0.217	.1915	39.6	.2500	
	4	0.10	124.3	13.7	10	0.072	.1843	21.3	.2406	
		0.20	109.3	28.7	20	0.145	.1647	36.3	.2150	
		0.30	96.7	41.4	30	0.217	.1557	49.0	.2032	0.3'*
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 219.1 ft.)						
4	3	0.20	132.0	87.1	80	0.365	.1804	102.4	.2355	
(20%)		0.30	85.6	133.5	120	0.548	.1735	148.8	.2265	
	4	0.10	164.0	55.1	40	0.183	.1585	70.4	.2069	
($\hat{y}$ =		0.20	111.9	107.2	80	0.365	.1417	122.5	.1849	
15.2')		0.30	63.0	156.1	120	0.548	.1341	171.4	.1751	0.2'*

(*: approximate run).

TABLE RSVS-6

Storage Equalization Computed Characteristics

Demand Schedule: Sinusoidal with $a/\overline{Q_d}$ = 0.766

Specific Speed : N_s = 4,000 N = 1,750 rpm

Variable Suction, a_s = 5.0 ft.

V, mg	n	ϕ	Y, Ft.	E_{pd} - Y, Ft.	$\phi\overline{Q_d}^2$	$\phi\overline{Q_d}^2/E_{pd}$	$U/\overline{Q_d}$	E_{pd} - Y + $\hat{y}$	U/a	Y-FSTE
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 ft.)						
8	2	0	199.4	-7.5	0	0	.2436	0.1	.3180	
(40%)		0.05	179.8	12.1	20	0.104	.2445	19.7	.3192	
		0.10	159.9	32.0	40	0.208	.2446	39.6	.3193	
($\hat{y}$ =		0.15	139.9	52.0	60	0.313	.2445	59.6	.3192	
7.6')		0.25	100.1	91.8	100	0.521	.2446	99.4	.3193	
	2.5	0.05	176.4	15.5	20	0.104	.2304	23.1	.3008	
		0.10	153.9	38.0	40	0.208	.2221	45.6	.2900	
		0.15	131.6	60.2	60	0.313	.2166	67.9	.2828	
		0.25	87.8	104.1	100	0.521	.2097	111.7	.2738	
	3	0.05	171.2	20.6	20	0.104	.2149	28.3	.2806	
		0.10	145.9	45.9	40	0.208	.2007	53.6	.2620	
		0.15	121.7	70.1	60	0.313	.1920	77.8	.2507	
		0.25	74.6	117.2	100	0.521	.1816	124.9	.2371	
	4	0.05	158.2	33.7	20	0.104	.1845	41.3	.2408	
		0.10	129.0	62.9	40	0.208	.1652	70.5	.2156	
		0.15	103.5	88.4	60	0.313	.1558	96.0	.2034	0.3'*
		0.25	54.8	137.1	100	0.521	.1455	144.7	.1899	0.4'*
				($\overline{Q_d}$ = 10 mgd; E_{pd} = 120.9 ft.)						
4	2.5	0.10	116.8	4.1	10	0.083	.2326	11.7	.3036	
(40%)		0.20	105.3	15.5	20	0.165	.2250	23.2	.2937	
		0.30	94.1	26.8	30	0.248	.2198	34.4	.2869	
($\hat{y}$ =	3	0.10	113.8	7.0	10	0.083	.2190	14.7	.2859	
7.6')		0.20	100.8	20.1	20	0.165	.2056	27.7	.2683	
		0.30	88.3	32.6	30	0.248	.1969	40.2	.2571	
	4	0.10	106.1	14.8	10	0.083	.1907	22.4	.2490	
		0.20	90.5	30.3	20	0.165	.1716	38.0	.2240	
		0.30	76.5	44.4	30	0.248	.1605	52.0	.2095	
				($\overline{Q_d}$ = 20 mgd; E_{pd} = 191.9 ft.)						
4	3	0.30	56.6	135.2	120	0.625	.1777	150.5	.2319	
(20%)	4	0.10	133.9	58.0	40	0.208	.1650	73.2	.2154	
($\hat{y}$ =		0.20	80.2	111.7	80	0.417	.1474	126.9	.1925	
15.2')		0.30	31.1	160.8	120	0.625	.1396	176.0	.1823	

(*: approximate run).

TABLE Q_p-VS1

Ratio $Q_p/\overline{Q_d} = Q_p/Q_{pd}$ for $a/\overline{Q_d} = 0.353$ (Belmont H.S.), in same order as runs listed in BSVS tables; largest and smallest $Q_p/\overline{Q_d}$ for 24-hr. of demand schedule.

TABLE BSVS-1		TABLE BSVS-2		TABLE BSVS-3		TABLE BSVS-4		TABLE BSVS-5		TABLE BSVS-6	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.966	1.034	.968	1.032	.925	1.025	.985	1.016	.986	1.015	.989	1.011
.973	1.025	.975	1.024	.979	1.020	.988	1.011	.989	1.011	.991	1.009
.978	1.021	.979	1.020	.982	1.017	.990	1.009	.991	1.009	.992	1.007
.982	1.018	.982	1.017	.985	1.014	.992	1.008	.992	1.007	.993	1.006
.986	1.013	.986	1.013	.988	1.011	.994	1.006	.994	1.005	.994	1.005
.968	1.032	.969	1.030	.975	1.025	.975	1.021	.976	1.020	.980	1.017
.960	1.035	.962	1.034	.967	1.029	.963	1.030	.964	1.028	.969	1.024
.954	1.039	.955	1.038	.960	1.033	.955	1.036	.957	1.035	.962	1.030
.945	1.045	.946	1.044	.951	1.040	.947	1.044	.947	1.042	.952	1.038
.950	1.043	.952	1.041	.960	1.034	.953	1.036	.955	1.034	.962	1.028
.931	1.056	.932	1.054	.941	1.047	.932	1.053	.934	1.051	.942	1.044
.919	1.066	.922	1.064	.929	1.056	.920	1.064	.922	1.062	.930	1.055
.906	1.078	.907	1.076	.914	1.069	.907	1.077	.958	1.075	.915	1.068
.911	1.067	.914	1.064	.925	1.054	.913	1.063	.916	1.060	.927	1.051
.882	1.092	.885	1.089	.896	1.028	.883	1.090	.886	1.087	.897	1.076
.866	1.108	.869	1.104	.879	1.094	.867	1.107	.869	1.103	.880	1.093
.850	1.126	.852	1.123	.860	1.114	.850	1.125	.852	1.122	.860	1.113
.956	1.044	.958	1.042	.966	1.035	.974	1.024	.975	1.022	.980	1.018
.957	1.042	.958	1.041	.964	1.035	.965	1.029	.966	1.027	.972	1.023
.953	1.043	.955	1.041	.961	1.036	.959	1.034	.959	1.032	.965	1.028
.948	1.051	.950	1.048	.959	1.040	.958	1.034	.959	1.032	.966	1.027
.934	1.057	.937	1.054	.945	1.047	.938	1.047	.941	1.045	.949	1.039
.923	1.064	.925	1.061	.934	1.053	.926	1.058	.928	1.056	.936	1.049
.918	1.066	.921	1.063	.932	1.054	.922	1.055	.925	1.052	.936	1.044
.890	1.086	.893	1.082	.905	1.072	.893	1.081	.895	1.078	.907	1.067
.874	1.100	.877	1.097	.887	1.086	.876	1.097	.878	1.094	.889	1.083

TABLE Q_p-VS2

Ratio $Q_p/\overline{Q_d} = Q_p/Q_{pd}$ for $a/\overline{Q_d} = 0.766$ (Royal Oak), in same order as runs listed in RSVS tables; largest and smallest $Q_p/\overline{Q_d}$ for 24-hr. of demand schedule.

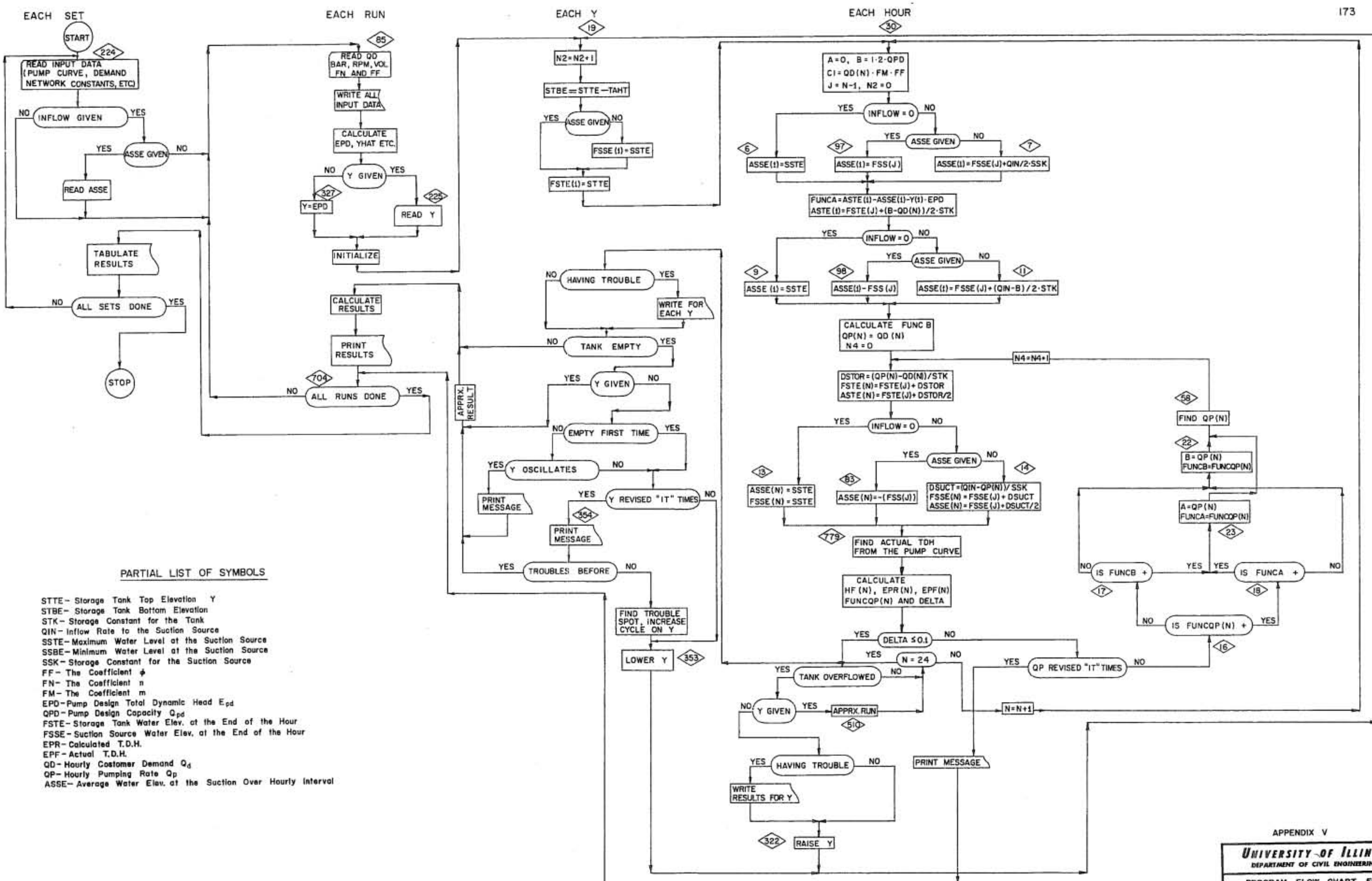
TABLE RSVS-1		TABLE RSVS-2		TABLE RSVS-3		TABLE RSVS-4		TABLE RSVS-5		TABLE RSVS-6	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
.961	1.039	.963	1.036	.972	1.028	.980	1.020	.981	1.018	.986	1.015
.969	1.028	.970	1.027	.976	1.021	.984	1.014	.985	1.013	.987	1.011
.975	1.023	.976	1.022	.979	1.018	.986	1.011	.987	1.011	.989	1.009
.978	1.019	.979	1.018	.982	1.016	.988	1.009	.989	1.009	.990	1.008
.983	1.014	.984	1.014	.985	1.012	.991	1.007	.991	1.006	.992	1.006
.913	1.055	.966	1.053	.930	1.043	.915	1.047	.918	1.044	.931	1.037
.877	1.073	.880	1.070	.895	1.060	.878	1.068	.882	1.066	.896	1.056
.856	1.085	.859	1.082	.873	1.073	.857	1.083	.860	1.080	.874	1.071
.832	1.102	.836	1.099	.847	1.090	.833	1.101	.837	1.098	.848	1.089
.822	1.094	.829	1.089	.849	1.075	.824	1.088	.830	1.084	.850	1.071
.768	1.129	.776	1.123	.794	1.109	.769	1.127	.777	1.122	.795	1.107
.740	1.152	.748	1.146	.764	1.132	.741	1.151	.749	1.145	.765	1.131
.711	1.179	.718	1.174	.731	1.161	.712	1.179	.719	1.173	.732	1.160
.666	1.166	.678	1.159	.699	1.140	.667	1.164	.679	1.156	.700	1.138
.615	1.215	.625	1.210	.643	1.191	.614	1.216	.625	1.208	.643	1.190
.590	1.251	.600	1.241	.615	1.221	.588	1.244	.598	1.235	.614	1.218
.565	1.285	.573	1.276	.585	1.266	.564	1.280	.571	1.271	.583	1.251

.920	1.065	.923	1.061	.937	1.050	.924	1.046	.927	1.043	.939	1.035
.919	1.075	.890	1.071	.905	1.060	.890	1.063	.893	1.060	.907	1.051
.866	1.083	.869	1.080	.884	1.070	.868	1.076	.872	1.073	.886	1.063
.838	1.093	.845	1.088	.865	1.074	.841	1.080	.848	1.076	.867	1.063
.783	1.121	.792	1.116	.811	1.101	.786	1.114	.794	1.109	.813	1.095
.754	1.142	.762	1.136	.780	1.121	.756	1.138	.764	1.132	.781	1.118
.685	1.155	.698	1.147	.719	1.130	.686	1.147	.699	1.140	.720	1.122
.630	1.203	.642	1.193	.660	1.175	.630	1.200	.642	1.191	.661	1.172
.603	1.234	.613	1.224	.630	1.204	.601	1.227	.612	1.219	.630	1.203

APPENDIX V

FLOW CHART AND SOURCE PROGRAM,

By R. Prasad



PARTIAL LIST OF SYMBOLS

STTE – Storage Tank Top Elevation Y
STBE – Storage Tank Bottom Elevation
STK – Storage Constant for the Tank
QIN – Inflow Rate to the Suction Source
SSTE – Maximum Water Level at the Suction Source
SSBE – Minimum Water Level at the Suction Source
SSK – Storage Constant for the Suction Source
FF – The Coefficient ϕ
FN – The Coefficient n
FM – The Coefficient m
EPD – Pump Design Total Dynamic Head E_{pd}
QPD – Pump Design Capacity Q_{pd}
FSTE – Storage Tank Water Elev. at the End of the Hour
FSSE – Suction Source Water Elev. at the End of the Hour
EPR – Calculated T.D.H.
EPF – Actual T.D.H.
QD – Hourly Customer Demand Q_d
QP – Hourly Pumping Rate Q_p
ASSE – Average Water Elev. at the Suction Over Hourly Interval

APPENDIX V

UNIVERSITY OF ILLINOIS
DEPARTMENT OF CIVIL ENGINEERING

PROGRAM FLOW CHART FOR DETERMINATION OF "Y"

(WP-526)

CIVIL ENGINEERING HYDRAULICS SECTION
DESIGNED AND DRAWN BY R. PRASAD
CHECKED BY R. PRASAD SCALE
DATE 1-15-1965 SHEET 1 OF 1

```
$      FORTRAN,GO,PUNCH OBJECT
$      PRINT OBJECT,DUMP
C
C
C1 *****SYSTEM BALANCING PROGRAMED BY R.PRASAD, REVISED IN  MAY 1964.***
C2*** FIXED SUCTION (WITH OR WITHOUT INFLOW) AS WELL AS VARIABLE SUCTION ***
C3*** BALANCING IS ALSO POSSIBLE WITH A GIVEN Y VALUF(S)  ******
C4*** THIS PROGRAM IS FINAL AND FOOL-PROOF AND HAS SEVERAL FEATURES TO TAKE CARE
C5 OF ALL THE TROUBLES. IT GIVES 2 COPIES OF PRINTED TABLES AT THE END OF EACH
C6 SET OF DATA ( TABLE IS ALSO ON PUNCHED CARDS )
C7*** NOTE--- SEVERAL SETS OF DATA CAN BE HANDLED,BUT D O  N O T PUT MORE
C8     THAN 55 RUNS PER SET  ********************----- R.PRASAD. NOV. 1964.
C
C
C     ************************ DECK MAKE-UP ****************************************
C 1   ONE CARD FOR TITLE(NAME OF THE NET-WORK,A ETC. UPTO 78 COLS.)
C 2   TWO CARDS FOR PUMP-CURVE.
C 3   TWO CARDS FOR SYSTEM DEMAND.
C 4   ONE CONTROL CARD WITH COEFFS. AND SYSTEM SWITCHES
C 5   (TWO CARDS IF VARIABLE SUCTION-LEVELS ARE GIVEN )
C 6   CARD OR CARDS HAVING VALUES OF QDBAR,RPM,VOL.,N AND FEE
C 7   IF Y VALUES ARE GIVEN, EACH Y VALUE CARD MUST BE PRECEEDED BY A CARD HAVIN
C 8  G QDBAR,RPM,VOL,N AND FEE  VALUES.
C     ************************ DECK MAKE-UP ************************************
C
C
      DIMENSION QD(25),FSTE(25),FSSE(25),ASSE(25),ASTE(25),EPR(25),EPF(2
     15),QP(25),FUNCQP(25),HF(25),KTIME(25),OVFLO (25),OVFLOW(25),OD(25)
     2,RATIO(25),TTL(13),QDM(25),SQDM(25),Y(8),H(8),Q(8),QCOE(8)
      DIMENSION NTLT(55),NCHKT(55),NSRPMT(55),QPDT(55),NRPMT(55),
     1EPDT(55),VOLUT(55),YHATT(55),FNT(55),FFT(55),YDT(55),RA1T(55),
2     RA2T(55),RA3T(55),RA4T(55),RA5T(55),PUSEDT(55),RMAXT(55),RMINT(55)
3     ,HFMAXT(55),HFMINT(55),NOKT(55),RAOT(55) ,FSS(25)
C
C **** FORMAT STATEMENTS  *******
C
    1 FORMAT(12F6.3)
    2 FORMAT(F2.0,F5.0,F2.0,F4.1,F5.3)
   90 FORMAT(     I3,I2,I5,F3.0,I5,F6.1,3X,F5.2,F5.1,F4.1,F6.3,3F6.1,
     1F5.3,F6.4)
   91 FORMAT(F6.1,F7.4,3X,F6.1,F5.2,F4.2,F6.1,F5.1,I3,I5)
   92 FORMAT(12F6.2 )
   96 FORMAT(1H-,47X,13A6)
   99 FORMAT(13A6)
  102 FORMAT (33H HEAD LOSSES WOULD NOT BALANCE IN,I4,14H ITERATIONS AT,
     1 I3, 6H HOUR//4H QD=,F7.2,3HQP=,F7.2,11H TDH(CALC)=,F9.2,11H TDH(A
     2CTL)=,F9.2 /50H SUGGESTED TO INCREASE THE NO. OF ITERATIONS, ,IT,)     C
  103 FORMAT(F6.2)
  104 FORMAT(18H **** NO RESULT IN,I4,20H ITERATIONS ON Y----// 70H
     1TANK IS NOT FULL AT THE END , LOOK THE RESULTS BELOW --APPRX.RUN )
  106 FORMAT(120HOY VALUES OSCILLATES,MAKE EC= .50 OR .60 ** CONSULT THE
     1 PROGRAMER (R. PRASAD )   CONVERGENCE SCHEME IS BAD.RESULT APPRX.)
  107 FORMAT(20X,I5,F7.2,F5.2,I4)
  108 FORMAT(20X,I5,F7.2,9H         24,F6.2)
  109 FORMAT(4X,I4,F7.2,F10.2,F8.2,F8.2,3X,F8.2,5X,4F8.2)
  110 FORMAT(47H                        ITER    YD+S OFLO  HR EMPTY)
  153 FORMAT(100HOSTORAGE TANK CHARACTERISTICS          SUCTION SOURCE CHA
     1RACTERISTICS         NETWORK CHARACTERISTICS)
  154 FORMAT(100H0 TANK VOL  TANK HT. QPD/QDBAR      INFLOW    TOP ELV  BOT
     1. ELV   MGD/FT.          FEE            N              M)
  155 FORMAT(10F10.3////)
  162 FORMAT(89H0   TIME    Q(D)       Q(P)        HF     TDH(C)      TDH(A)
     1     FSTE     ASSE    PUSED OVRFLOW//)
```

```
  200 FORMAT(I2,4F5.0,5F4.0,F5.0,I4,2F4.1,F5.3,I3 )
  228 FORMAT(8HOAVERAGE,F7.2,F10.2,70X,I5///)
  232 FORMAT(122H-RUN H   NS QD  RPM   EPD      VOL YHAT  EN   FEE  YD+S
     1EPD-Y F*QD2 /EPD U/QDB 12+YH   U/A      PUSED RMAX RMN HFMAX HFMN O
     2K//)
  233 FORMAT(1H ,I3,I2,I5,F3.0,I5,F6.1,3X,F5.2,F5.1,F4.1,F6.3,3F6.1,
     1F5.3,F6.4,F6.1,F7.4,3X,F6.1,F5.2,F4.2,F6.1,F5.1,I3)
  234 FORMAT(1H1)
  236 FORMAT(8F6.3,F7.0 )
  302 FORMAT(32H0  NS  RPM QD  VOL   FEE  EN RUN)
  935 FORMAT(2F5.0,F3.0,F5.2,F6.3,F4.1,I4 )
      DO227N=2,25
  227 KTIME(N)=N-1
C
C
C  *****  READS DATA FOR A GIVEN SET   *******
C
  224 RIT7,99,TTL
      WOT5,99,TTL
      READ INPUT TAPE7,236, (Y(I),I=1,8),ANSS
      READ INPUT TAPE7,236, (QCOE (I),I=1,8),ANSS
      READ INPUT TAPE 7,1,(OD(N),N=2,25)
      RIT7,200, ITR,QIN,SSTE,SSBE,SSK,EC,OC,RKK,CONST2,FM,TAHT,IT,VFA,
     1QDFA,AA,NRUN
   56 N3=QIN
      IT2=2*IT
        NTL=ANSS/10.0
       NSRPM=ANSS
      IF ( QIN )84,85,85
   84 RIT7,92, (FSS(J),J=1,24 )
   93 DO95J=1,24
   95 FSSE(J+1)=FSS(J)
C
C
C *****  INPUT AND COMPUTATIONS FOR A NO. OF RUNS IN A GIVEN SET OF DATA
C BEGINS   **************************
C
   85 DO 704 L=1,NRUN
      RIT7,2,CONST1,ANS, VOLU,FN,FF
      NRPM=ANS
      VOLU= VOLU* VFA
      NTL=NTL+1
  226 WOT6,234
      WRITE OUTPUT TAPE6,302
       WOT6,935,ANSS,ANS,CONST1,VOLU,FF,FN,NTL
      WRITE OUTPUT TAPE 6,153
      WRITE OUTPUT TAPE6,154
      WRITE OUTPUT TAPE 6,155,VOLU,TAHT,RKK,QIN,SSTE,SSBE,SSK,FF,FN,FM
      IF(ITR)330,330,331
C
C
C ****  CALCULATIONS OF QDBAR,EPD,YHAT,STORAGE CONSTANT ETC.  **************
C
  331 WOT6,110
  330      CONST1=CONST1*QDFA
  245 CONST3=CONST1/CONST2
      DO399I=2,25
      QD(I)=CONST3*OD(I)
  399 QDM(I)=OD(I)-1.
    3 SUMQ=0.
      DO 5 I=2,25
    5 SUMQ=SUMQ+QD(I)
      AVGQD=SUMQ/24.0
```

```
          QPD=RKK*SUMQ/24.
          EPD=(((QPD/.00144)**0.5)*ANS/ANSS)**1.3333
          DO901 I=1,8
          H(I)=Y(I)*EPD
      901 Q(I)=QCOE (I)*QPD
          SQDM(2)=QDM(2)
          DO899 I=3,25
      899 SQDM(I)=SQDM(I-1)+QDM(I)
          SM=0.
          DO898 I=2,25
      898 SM=SM+SQDM(I)
          YHAT= (SM*25.0*AVGQD) / (576.0*VOLU )
          STK=24.*VOLU/TAHT
          IF(ITR)225,327,327
225       RIT7,103,STTE
          GO TO 328
327       STTE=EPD
    C
    C
    C  ***********    INITIALIZATION ETC.    ********************
    C
328       N2=0
          C5=0.
          NOK=1
          HFMAX=0.
          RMAX=0.
          RMIN=999.
          HFMIN=999.
          FMIN=1000.0
          NTLT(L)=NTL
          NSRPMT(L)=NSRPM
          QPDT(L)=QPD
          NRPMT(L)=NRPM
          EPDT(L)=EPD
          VOLUT(L)=VOLU
          YHATT(L)=YHAT
          FNT(L)=FN
          FFT(L)=FF
          YDT(L)=0.
          RA1T(L)=0.
          RA2T(L)=0.
          RA3T(L)=0.
          RA0T(L)=0.0
          RA4T(L)=0.
          RA5T(L)=0.
          PUSEDT(L)=0.
          RMAXT(L)=0.
          RMINT(L)=0.
          HFMAXT(L)=0.
          HFMINT(L)=0.
          NCHKT(L)=9
          NOKT(L)=9
    C
    C
    C  *****  ITERATIONS ON Y BEGINS  *****************
    C
       19 N2=N2+1
      320 STBE=STTE-TAHT
          IF (N3)196,94,94
       94 FSSE(1)=SSTE
      196 FSTE(1)=STTE
    C
    C
```

```
C*****HOURLY BALANCING LOOP BEGINS   ************
C
   30 DO 10 N=2,25
      A = 0.0
      B=1.2*QPD
      J=N-1
      C1=QD(N)**FM*FF
      ASTE(1)=FSTE(J)-QD(N)/2./STK
      IF(N3)97,6,7
    6 ASSE(1)=SSTE
      GO TO 8
    7 ASSE(1)=FSSE(J)+QIN/2./SSK
      GO TO 8
   97 ASSE(1)=FSS(J)
    8 FUNCA=ASTE(1)-ASSE(1)-Y(1)*EPD
      ASTE(1)=FSTE(J)+(B-QD(N))/(2.*STK)
      IF(N3)98,9,11
    9 ASSE(1)=SSTE
      GO TO 12
   11 ASSE(1)=FSSE(J)+(QIN-B)/(2.*SSK)
      GO TO 12
   98 ASSE(1)=FSS(J)
   12 FUNCB=ASTE(1)-ASSE(1)-Y(6)*EPD +C1*(B/QD(N))**FN
      QP(N)=QD(N)
      N4 = 0
   57 N4 = N4 + 1
      DSTOR=(QP(N)-QD(N))/STK
      FSTE(N)=FSTE(J)+DSTOR
      ASTE(N)=FSTE(J)+DSTOR/2.
      IF(N3)83,13,14
   13 ASSE(N)=SSTE
      FSSE(N) = SSTE
      GO TO 15
   14 DSUCT=(QIN-QP(N))/SSK
      FSSE(N)=FSSE(J)+DSUCT
      ASSE(N)=FSSE(J)+DSUCT/2.
      GO TO 15
   83 ASSE(N)= -1.0* FSS(J)
C
C  ***** FOR A GIVEN QP , TO FIND EP FROM THE TABLE OF PUMP CURVE  *********
C
   15 QP=QP(N)
  779 EP= TAB(QP,Q,H,1,1,5,8,SW)
      HF(N)=C1*(QP(N)/QD(N))**FN
      EPR(N)=ASTE(N)-ASSE(N)+HF(N)
      EPF(N)=EP
      FUNCQP(N) = EPR(N) - EPF(N)
      DELTA=ABSF(FUNCQP(N))
      IF(DELTA-.10)21,21,20
   20 IF (N4-IT) 16,16,59
   16 IF(FUNCQP(N))17,17,18
   17 IF(FUNCB)22,22,23
   18 IF(FUNCA)22,22,23
   22 B=QP(N)
      FUNCB=FUNCQP(N)
      GO TO 58
   23 A=QP(N)
      FUNCA=FUNCQP(N)
   58 QP(N) = (B*FUNCA - A*FUNCB)/(FUNCA - FUNCB)
      GO TO 57
   59 WRITE OUTPUT TAPE 6, 102,IT,J,QD(N),QP(N),EPR(N),EPF(N)
      GO TO 704
C
```

```
C*****SYSTEMS CHECK FOR OVER FLOW OF TANK*****
C
   21 OVFLO(N)=FSTE(N)-STTE
      OVFLOW(N)=100.*(FSTE(N)-STTE)/TAHT
  329 IF(OVFLO(N)-0.004)10,10,28
   28 IF(ITR)510,322,321
  321 WOT6,107,N2,STTE,OVFLO(N),J
  322 STTE=STTE+OVFLO(N)*OC
      GO TO 19
  510 NOK=-1
   10 CONTINUE
C
C
C *******HOURLY BALACING LOOP ENDS*****
C
C*******SYSTEMS CHECK FOR FINAL TANK-LEVEL ********
C
  778 C3=FSTE(25)-STTE
      C4=ABSF(C3)
      IF(ITR)324,324,323
  323 WOT6,108,N2,STTE,C4
  324 C32=C3*EC
      IF(C4-0.1)151,52,52
   52 IF (ITR)150,752,752
  752 C6=ABSF(C5-C4)
      IF(C6-.004)149,149,352
  352 C5=C4
      IF(N2-IT2)353,353,354
  354 WOT6,104,IT2
      IF(ITR)150,705,150
  705 ITR=1
      IT2=3*IT
      WOT6,110
  353 STTE=STTE+C32
      GO TO 19
C
C
C*****ITERATION ON Y ENDS*****
C
C******CALCULATES RESULTS FOR EACH RUN *************
C
  149 WOT6,106
  150 NOK=0
  151 AQP = 0.
      IF(ITR)326,326,325
  325 WRITE OUTPUT TAPE6,234
      WRITE OUTPUT TAPE6,302
      WOT6,935,ANSS,ANS,CONST1,VOLU,FF,FN,NTL
      WRITE OUTPUT TAPE 6,153
      WRITE OUTPUT TAPE6,154
      WRITE OUTPUT TAPE 6,155,VOLU,TAHT,RKK,QIN,SSTE,SSBE,SSK,FF,FN,FM
  326 DO 55 J=2,25
   55 AQP = AQP + QP(J)
      AVGQP = AQP/24.
      DO199I=2,25
  199 FMIN=MIN1F(FMIN,FSTE(I))
      DO797I=2,25
  797 RATIO(I)=QP(I)/QD(I)
      DO499I=2,25
  499 RMIN=MIN1F(RMIN,RATIO(I))
      DO599I=2,25
  599 RMAX=MAX1F(RMAX,RATIO(I))
      DO699I=2,25
```

```
  699 HFMAX=MAX1F(HFMAX,HF(I))
      DO799I=2,25
  799 HFMIN=MIN1F(HFMIN,HF(I))
      USED=STTE-FMIN
      PUSED=100.0*USED/TAHT
      YD=STTE
      U=VOLU*USED/TAHT
      RA0=U/AVGQD
      RA1=EPD-YD
      RA2=FF*(AVGQD)**2.0
      RA3=RA2/EPD
      RA4=RA1+YHAT
      RA5=RA0/AA
      EPD1=0.75*EPD
      IF(YD-EPD1)701,701,702
  701 NCHK=0
      GO TO 703
  702 NCHK=1
C
C
C******PRINTS RESULTS FOR EACH RUN   *****************
C
  703 WRITE OUTPUT TAPE 6,162
      WRITE OUTPUT TAPE 6,109,(KTIME(N),QD(N),QP(N),HF(N),EPR(N),EPF(N),
     1FSTE(N),FSSE(N),OVFLOW(N),OVFLO(N),N=2,25)
      WRITE OUTPUT TAPE6,228,AVGQD,AVGQP,N2
      WRITE OUTPUT TAPE6,232
      WRITE OUTPUT TAPE6,233,NTL,NCHK,NSRPM,QPD,NRPM,FPD   ,VOLU,YHAT,FN,
     1FF,YD,RA1,RA2,RA3,RA0,RA4,RA5,    PUSED,RMAX,RMIN,HFMAX,HFMIN,NOK
      WOT6,96,TTL
      WRITE OUTPUT TAPE5,90 ,NTL,NCHK,NSRPM,QPD,NRPM,EPD   ,VOLU,YHAT,FN,
     1FF,YD,RA1,RA2,RA3,RA0
      WOT5,91,RA4,RA5,    PUSED,RMAX,RMIN,HFMAX,HFMIN,NOK,NTL
      NCHKT(L)=NCHK
      YDT(L)=YD
      RA1T(L)=RA1
      RA2T(L)=RA2
      RA3T(L)=RA3
      RA0T(L)=RA0
      RA4T(L)=RA4
      RA5T(L)=RA5
      PUSEDT(L)=PUSED
      RMAXT(L)=RMAX
      RMINT(L)=RMIN
      HFMAXT(L)=HFMAX
      HFMINT(L)=HFMIN
      NOKT(L)=NOK
      IF(ITR )704,704,777
  777 ITR=0
  704 CONTINUE
C
C
C   ******* COMPUTATIONS FOR A NO. OF RUNS IN A GIVEN SET OF DATA ENDS  ****
C
C  ****  TABULATION OF RESULTS FOR THE SET OF DATA STARTS   *****************
C
C
  776 DO706L=1,2
      WOT6,234
      WOT6,96,TTL
      WRITE OUTPUT TAPE6,232
      WOT6,233, (NTLT(I),NCHKT(I),NSRPMT(I),QPDT(I),NRPMT(I),EPDT(I),
     1VOLUT(I),YHATT(I),FNT(I),FFT(I),YDT(I),RA1T(I),RA2T(I),RA3T(I),RA0
```

```
     2T(I),RA4T(I),RA5T(I),    PUSEDT(I),RMAXT(I),RMINT(I),HFMAXT(I),HFMI
    3NT(I),NOKT(I),I=1,NRUN)
  706 CONTINUE
C
C
C*****REPEATS WITH ANOTHER SET OF DATA*******
C
      GO TO 224
      END
$   DATA
  B.H.S. (A=0.353 ) VARIABLE SUCTION (EX. FOR DECK MAKE-UP)---R.PRASAD.TITLE  1
 1.185 1.088 1.049 1.000 0.942 0.870 0.040 0.000   2200=NS               PC     2
 0.000 0.8   0.9   1.0   1.1   1.2   1.810 1.830   2200=NS               PC     3
 1.046 1.135 1.214 1.279 1.325 1.349 1.349 1.325 1.279 1.214 1.135 1.046BT 353 4
 0.954 0.865 0.786 0.721 0.675 0.651 0.651 0.675 0.721 0.786 0.865 0.954BT 353 5
 1    .0000.0   .0   .0 .97 .50 1.0 1.0 2.0 25.0  19 1.0 1.0 .353  1   CONTROL6
C  ****  PUT CARD HERE IF VARIABLE SUCTION IS GIVEN
20 1150 4 2.0 .1          THIS CARD HAS QDBAR,RPM,VOL,N AND FEE
C  ****** Y VALUES HERE IF GIVEN ****
```

APPENDIX VI

ARTICLE ON PROJECT IN "ENGINEERING OUTLOOK"

Description of Research Study on "Criteria for Analysis of Water Distribution Systems" as it appeared in Engineering Outlook, University of Illinois Engineering Experiment Station Bulletin, Vol. 5, No. 9, November, 1964.

THE WATER EXPLOSION

Increasing prosperity and the population explosion are being accompanied by the "water explosion" -- an increasing public demand for high-quality water. A continually increasing number of consumers expect an adequate supply of water at high pressure at all times of the day and night, and present-day distribution systems are being expanded to meet predicted demands. A group of researchers at the University of Illinois are studying the problems involved and are looking for answers to them.

Most water distribution systems are put under pressure by means of centrifugal pumps that operate most efficiently in a limited range near their design capacity. To meet wide fluctuations in demand it is normal to operate a complement of pumps of different design capacities in various combinations. To back up the pumps during peak usage periods a "silent pumping station," which is an elevated tank or a high-level ground storage reservoir, can be used. Such storage improves pumping efficiency by equalizing the output from pumping stations and by stabilizing system pressures. In the event of pumping station power failure, demand is served for a reasonable time exclusively from storage. The equalizing feature is also of great benefit when large flows for fighting fires are required. With equalizing storage, a whole day of demand can be met with a single pump, or at most with two pumps, making the system more susceptible to automatic or remote-control operation.

Today, the designer of a water distribution system is faced with many choices for expansion, but only a few combinations of distribution piping, elevated storage, and pumps will meet service requirements with minimum capital outlay and optimum operating costs. The research group in the Department of Civil Engineering, which is under the direction of Professor M. B. McPherson, is studying criteria for the analysis of water distribution systems under a Public Health Service research grant. With the aid of a computer, the researchers will evaluate all combinations of pumps, storage capacity, demand schedules, pipe networks, and other variables required for full exploitation of equalizing storage.